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**What is lesson preparation  
to a Waldorf teacher working out of  
Art, Science and Religion?**

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# ABSTRACT

## **How a unification of art, science and religion can be achieved in education, and whether this can lead to higher levels of knowing**

This study builds a theoretical basis to support the unification of art, science and religion in education. Understanding and utilisation of this unification is fundamental to Waldorf teaching, and therefore a necessary aspect of lesson preparation by Waldorf teachers. The study compares the historical understanding of these subject domains with more contemporary associations such as wisdom, spirituality, creativity and intelligence. The study reveals how these connect with the values of truth, beauty and goodness, and the activities of thinking, feeling and willing. Building on this, the research demonstrates how resource material for such a teaching process can be organised for lesson preparation, and explores whether such an approach can lead to higher levels of knowing.

Stage one of the research used a combination of action research and auto-ethnological methodologies combined with meditative practices to examine how a unification of art, science and religion could be achieved in lesson preparation around a particular theme. Stage two of the research delved into whether and how this unification could lead to a crossing of subject domains, and whether and how it could lead to higher levels of knowing. Stage three of the research involved the compilation of a teacher's resource book showing examples of how a unification of art, science and religion could be achieved. It forms the creative artifact to this submission. The selection and creation of material for this book formed the main body of the research done in stage one. The analysis of material gathered in stage one, along with further analysis exploring possibilities of higher knowing in stage two, informed the selection of material and layout of the book done in stage three.

The outcomes of stages one and two of the research, showed and refined how a combination of art, science and religion could be achieved, and how the crossing of these subject domains was a necessary platform from which higher levels of knowing could develop. It validated the need for a teacher's resource book that demonstrated a combination of art, science and religion. This book could be of benefit to teachers of all disciplines, but may be particularly helpful to Steiner teachers, where the unification of art, science and religion form the basis of their Waldorf pedagogy. Since recent research shows the success of Waldorf education in developing in its students the responsibilities needed for the twenty first century, a deeper understanding of this approach is valid for all educationalists.

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### **Attestation of Authorship**

“I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.”

Josephine Susan Erskine

A handwritten signature in dark ink, appearing to read 'J. Erskine', is centered below the printed name. The signature is fluid and cursive, with a large initial 'J' and 'E'.

The teachers' resource book, produced as a creative component of this thesis, may be reproduced with this thesis for university learning purposes only. The teachers' resource book is the intellectual property of the author, and may be individually published by the author at a later date.

# 1. INTRODUCTION

The main enquiry of this thesis is into the unification of art, science and religion in education, how this can be achieved, and whether a unification of these subjects can lead to higher levels of knowing. This process is integral to the underlying ideals of Waldorf education, also known as Steiner education, and yet has implications for education in general. This study will demonstrate one Waldorf teacher's approach to lesson planning (my own), demonstrating and examining the unification of art, science and religion. The outcome of this research will be collated in a teachers' resource book as a creative artefact to this exegesis.

## 1.1 My Background

Before going into any further discussion on why I have chosen this topic, it is relevant to explain my own background, as this has an epistemological bearing on the validity, scope and justification of my own knowledge regarding this theme. Throughout this thesis, I have made comments based on my own judgement with regards to visual art works and appropriateness of lessons for students. I have also made comments regarding Waldorf education based on my own experience. In support of these comments, I give the following synopsis of my biography.

I am a practising artist and Waldorf teacher in my early fifties. I began my adult career as a graphic designer and illustrator thirty years ago, and enjoyed a successful career in this industry. Twenty years ago I became interested in Waldorf education and began training and teaching in this area. Over the last twenty years, I have blended several career paths working as a designer, illustrator, exhibiting artist, art teacher, art history teacher and technology teacher. I have also taught other specialty subjects including history, philosophy and geometry. I am privileged to have had the opportunity to work in such a range of areas, but it has been the visual arts that has formed the central focus of my work. It was from a love of art that I widened my focus into all aspects of visual design. It was a love of art



history that widened into a study of history, and philosophy. It was also through art that I studied draughtsmanship, which developed on into an interest in geometry. Art was my first love, but I did not see it as a stationary structure with limits that I needed to stay within. To me boundaries were something that existed only in the eyes of others, and so my passion for art spread across subject domains.

As a career-focused woman living in the age of technological change I felt a responsibility to understand the science of the world around me. At the beginning of my career this involved understanding the chemical reactions of the different materials I used, the effects of light on photography film, the chemistry and mechanics of print processes, and later, the physics of how computers and digital networks operate.

As a child I was brought up in a Catholic family, attending church and a mix of Catholic- and State schools. Like many teenagers, I looked away from family traditions to find my own answers to ontological questions. I became interested in many philosophies, developing a respect for diversity of thought and spiritual experience. In my late twenties, I became interested in the work of anthroposophy<sup>1</sup>, seeing this as an all-encompassing, boundless movement that incorporated diversity, as well as something that reached out to my inner self. Anthroposophy, based on Rudolf Steiner's spiritual science, forms the foundation on which the Waldorf Education movement is built. I am a Waldorf teacher and I am an anthroposophist.

My background shows a love of art, with significant experience in the subject, a sense of responsibility to understand the scientific and technological processes I make use of, and a developing scientific approach to spiritual enquiry that incorporates my respect for diversity of thought and experience. In this way I have unified art, science and spirituality within my own life. That spirituality can be synonymous with religion in this context will be explained in the literature review. My question for this study is whether and how this can be achieved in education, and whether my belief that this leads to higher levels of knowing, is able to be supported.

<sup>1</sup> Anthroposophy is the name given by Rudolf Steiner to describe what he refers to as spiritual science. It involves a comprehensive picture of the human being which includes body, soul and spirit. See *Roots of Education* for an overview of how this relates to education (Steiner 1924/1997).

## **1.2 Others interested in art, science and religion**

The German idealist Hegel saw art as something that could be brought forth out of the idea of the objective spirit, or ideal truth (Stace, 1955, p. 441). He saw art as that spiritual quality that glimmers through matter as beauty. But to Hegel art could never fully embody the objective spirit, which would then lean towards the pure thought of philosophy. In this regard he saw philosophy as a pure dialectic methodology, a scientific process of logical thinking. He saw that humankind's inability to see the objective spirit in its pure form led to a need to cognise it, but in a way that is partly sensuous and partly rational, thus taking on the form of religion. To then understand the objective spirit in its pure form, Hegel thought the human being must strip away unsubstantial embellishments, until philosophy remains (Stace, 1955). Therefore to Hegel art and religion were a necessary part of the process of uncovering truth as scientific reason.

To Rudolf Steiner, the founder of anthroposophy and the Waldorf Education movement, art and religion were not just a tool for the unveiling of a scientific logic. Truth was something far more expansive than Hegel's objective logic could ever reach. Subjective experience was of equal importance to Steiner, and he saw an equal and effectively placed unification of art, science and religion as central to the aims of education. He saw this amalgamation as necessary for the next stage in human development. (Steiner, 1919d/2000; 1919a/1995; 1920/2001; 1920-23/2007; 1921-22a/1995; 1921-22b/1996; 1921-22c/2003; 1923c/2004).

To the Pragmatic philosopher Dewey, a set of values developed only out of tradition, belief or feelings could not work. He thought that these must be balanced by scientific knowledge. He saw imagination and creativity as something that was integral in religion, science and art, concluding that aesthetic experience was the key to their integration. To Dewey the arts should be taught in schools in conjunction with religious values and science, because the arts nourished and developed the imagination. (Sloan, 2012).

Whitehead also acknowledged a rift between science and religion and stressed the need to reconcile them. Like Steiner, he rejected the idea of a dualism of spirit and matter, and also of a monism placing either of these first. Whitehead wanted to see a harmony of scientific

and religious thinking. (Griffin, 2012) American philosopher and psychologist William James also rejected one sided views of science such as positivism and Kant's critical philosophy, because he could not see how these ways of thinking could account for the intense depth of religious experiences. (McDermott, 1991).

In Ken Wilber's integral philosophy, he looked for a marriage between religion and science, relating these to soul and sense. He wanted to separate out the true, the beautiful and the good, freeing these from out dated constructs, before integrating them back together again (Filipsone, 2009). Howard Gardner also sought to integrate truth, beauty and goodness, viewing the notions of science, art and religion in a new light (Gardner, 2011b). How these values relate to art, science and religion is explained later in this introduction.

Robert Sternberg also looks at the importance of unifying art science and religion, but focuses more on what is developed in the human being through them. Science is reawakened as intelligence, Art becomes creativity, and religion transforms into wisdom (Sternberg, 2003).

There is growing academic evidence that points to the importance of integrating the artistic with the scientific (Gidley, 1998; Kennedy, 2006; McCabe, Neill, Granville, & Grace, 2013; Pellico, Friedländer, & Fennie, 2009), and the impact this has on developing moral social behaviour (Boske, 2012; Missouri Alliance for Arts Education, 2010; Uptis, Smithrim, Garbati, & Ogden, 2008). Webster (2004) stresses the importance of ensuring that students who do not come from religious backgrounds are given the opportunity to access spiritual development, while the psychologist Vaughan (2003) gives a scientific explanation of what spiritual intelligence is, giving it a rational value.

### **1.3 The problematisation of terms**

I have chosen to use the terms science, art and religion in this study because they are terms used by Steiner, who uses them in context with a historical evolution of consciousness.

However, as Foucault points out, our constructs that define what truth is, change in different periods of history, and as such our definition of these three terms have now become what

Foucault refers to as problematised (Foucault, 1969; 1984). Science and art have many branches, and what determines an art or a science has drastically changed since the terms were first defined. Religion has many denominations and branches and is associated as much with specific, practiced traditions, as it is with inner experiences. In my opinion, each of these terms is now related more with their manifold outer projections than with their original sources.

Gardner and Wilber reallocate these terms to relate to truth, beauty and goodness (Filipsone, 2009; Gardner, 2011b). Steiner does this also, but not when referring to them in their historical context (1919d/2000). Sternberg takes the transformation further, reconstructing them in their humanised manifestations of intelligence, creativity and wisdom (2003). However we can see that, as early as in Dewey's writing, creativity is not just related to art and beauty, but also to religion and science (Sloan, 2012).

The use of the word religion is the most complicated. Steiner and other philosophers up to the early twentieth century used the term religion freely in reference to spiritual religiosity as well as a formalised religion. But in later times the word has become synonymous with formalised religions, specific practices, sometimes dogmatic approaches to spirituality and even fundamentalist ideas (Grace, n.d.). For this reason I have replaced the word with spirituality in my teachers' resource book. However in this exegesis I have retained the word religion, in keeping with the definition I have attempted to give below.

## **1.4 Defining art, science and religion for use in this thesis**

Each of these three terms has a broad range of definitions from the generic to the specific. Rudolf Steiner uses them in a generic form to build a picture of the overarching structure of anthroposophy in which Waldorf education is based. Steiner borrowed these terms from earlier figures he was strongly influenced by. These included the philosophers Fichte and Schelling, and the poet and scientist Goethe (Selg, 2012). Steiner was also strongly influenced by Christian Rosenkreutz, whom he stated worked with the amalgamation of these three streams (Selg, 2012). Steiner

saw anthroposophy as a continuation of the work of Rosenkreutz, and so retained these historical terms.

However as mentioned above the generic meaning Steiner associated with these terms is open to misinterpretation. That terms Steiner uses are sometimes translated differently is not helpful, as is the fact that Steiner did not clearly explain how he defined them; it is necessary to read widely in order to gain the overview.

We can however unravel their explanation by placing them alongside other word triads that Steiner used in conjunction with the terms ‘science’, ‘art’ and ‘religion’. One such example is the platonic triad of ‘truth’, ‘beauty’ and ‘goodness’. Plato saw the triad as what made up the eternal and transient world of forms. ‘Good’ to Plato was the universal priority, from which all things exist. The Greek word for truth is *aletheia* meaning non-concealment, or how things derived their nature from the absolute good. And beauty needed to incorporate both truth and goodness in order to be beauty (Turley, 2014). We can see how these all relate to values, but the ‘good’ relates to the absolute good of the world of archetypal forms, thus relating to the idea of spirituality or an archetype of religion. Truth relates to a striving to understand material things as they really are, which relates to the original idea of science. While beauty relates to Hegel’s description of art, where the spiritual can be seen shining through matter (Stace, 1955).

Steiner gave a lecture in which he described truth, beauty and goodness, linking them to what he called the physical, the etheric and astral bodies of the human being<sup>2</sup> (1923c/2000). He linked goodness directly to the astral body, leading mankind into the future. For Steiner truth creates a connection with original spirituality, and links the human being to the past through the physical body. Beauty links man’s

<sup>2</sup> Steiner describes the physical body as being that part of the human being that is similar to minerals, he describes the etheric body as that part of the human being that is similar to plants, and he describes the astral body as that part of the human being which is similar to animals. He goes on to describe seven bodies, but it is these three that relate to education particularly. These terms are repeated throughout his works, but more can be found on them in relation to education in ‘The Foundations of Human Experience’ (Steiner 1919b/1996)

etheric body to present-day spirituality (Steiner, 1923c/2000). What is of further interest here, is that Steiner also linked the triad ‘thinking’, ‘feeling’ and ‘willing’ to past, present and future, linking thinking to remembering the past, willing as planting seeds for the future, and feeling as the transition between the two (Steiner, 1919d/2000). Regarding pedagogy, throughout his educational works he linked the first seven years of childhood<sup>3</sup> to goodness, to the importance of religion, reverence, the limbs, to the development of will and to the later part of the day. He links the second seven years of childhood to beauty, to the development of pictorial concepts, to a respect for authority, the heart, breathing and rhythmic system, to the cultivation of feeling experiences, and to the middle of the day. The adolescent years, the third seven year period, he links to truth, to the development of logic, the head, to freedom in thinking, and to the first part of the day. (Steiner, 1904/1994; 1919d/2000; 1919a/1995; 1919c/1997; 1920/2001; 1920-23/2007; 1921-22b/1996; 1923b/1997; 1923c/2000; 1924a/1997).

We can therefore draw from this that to Steiner, Science related to the truth, art related to beauty, and religion related to goodness. We can also see how these relate to thinking, feeling and willing, as well as other triads, but to simplify things I put forward the following definitions.

*Science = the pursuit of truth through thinking*

*Art = beauty, experienced through feeling*

*Religion = striving for goodness through the will*

To Steiner the meaning of Science, Art and Religion is less concerned with subject domains, and more with three different kinds of human activity. Yet each can be applied to any curriculum subject. Science is not limited to physics or biology, but can be found also in aesthetics when thinking about the laws of the golden section. Art can be experienced through

<sup>3</sup> Steiner repeatedly referred to seven-year cycles of human development which continue on throughout life, however since the first three take a person up to twenty-one he relates these particularly to education. More can be found out on these in his book ‘The Childs Changing Consciousness’ (Steiner, 1923a/1996).

the feelings generated by observing the colour changes in a chemistry experiment. Religion can be striven for through the development of positive expectations of one's own standards in all activities, interactions and considerations of the whole. (Steiner, 1918/1949; 1919d/2000; 1919a/1995; 1920-23/2007; 1921-22b/1996; 1923b/1997; 1923c/2000; 1924a/1997).

## **1.5 Defining 'levels of knowing' and 'student ability'**

I have used the term 'levels of knowing' throughout this thesis, by which I am referring to more than intellectual understanding, or observation, but also a feeling of knowing, and a sense or ability to do something physically. By the term 'student ability' I refer to the degree of mastery a student has of the technical skills required to do a particular activity. These terms have unfolded through my long experience in the classroom.

## **1.6 The future value of this research**

As previously mentioned, there is growing academic research that points to the importance of integrating science, art and religion. The New Zealand curriculum for education also encourages cross-curricular teaching (Ministry of Education, 2007), but since teaching still takes place upon the pre-existing structure of separate subject departments, communication between them is difficult. I believe that alternative educational systems such as Steiner education, can offer a better ground on which to explore this theme further, and develop a deeper understanding of it. The theoretical basis developed out of a study of this integration, is something I see as useful information for all education platforms. Particularly if it shows, as I believe, that this integration leads to higher levels of knowing.

In my experience as a Waldorf teacher, the vast majority of the work of teaching is done in the preparation. This does not only entail the development of academic resources, standards and practical preparations, but also of meditative considerations, which integrate the teaching with the students in multiple ways, creating an overarching holistic approach to learning. In this respect, Steiner education requires commitment and dedication on a level quite different to that usually

expected of teachers (Steiner, 1919b/1996). The educational training of Waldorf teachers is thus a very difficult process, for it must incorporate tertiary platforms of study, and at the same time holistic meditative approaches which are difficult to validate by academic means. In this thesis I am attempting to demonstrate how that bridge can be crossed.

The educating of Waldorf teachers is not something that can be confined to academic study alone, it requires a study of, and preferably a commitment to engage in, Anthroposophy. This engagement is a difficulty when examining tertiary Waldorf teaching platforms, as anthroposophy can only be creatively experienced and lived into, it cannot be learned through intellectual means alone. Furthermore it is important to acknowledge that Waldorf teaching misses its aim wherever it becomes a method. Steiner described teaching as an artistic process (Steiner, 1919a/1995, 1924a/1997), and I hope to demonstrate one teacher's approach to the creative process involved.

I intend to document an area of this usually hidden process, so that the documentation can act as a demonstration to teachers, new to Steiner education, of the inner process involved in this educational approach (Steiner, 1920-23/2007). This documentation can be viewed in Appendix C. Secondly, I intend to analyse and evaluate the research gathered using both academic and meditative approaches to select material suitable for use in teaching. This is explained in the methodology chapter and discussed in the research chapters. Thirdly, I will produce a teacher's resource book that may inspire the creative preparation of other teachers, which accompanies this thesis as a separate document.

Lastly I would like to deepen academic understanding of what Waldorf teaching practices can be. Gidley (1998; 2002) has provided research showing that Waldorf school students have what "futurists" refer to as the 'responsibilities' that are necessary for young people to have in the twenty first century. Gidley says that Waldorf students experience fears about the future common to young adolescents throughout the Western world. However unlike the growing trend of hopelessness emerging in the feelings of young people, Waldorf students have feelings of empowerment, and they are actively optimistic about making changes for a better future. If an educational system can engender such, much needed, and time-appropriate results in its students, then further knowledge and understanding of the processes underlying this education system should be valuable for all educational philosophy.



## 2. LITERATURE REVIEW

### 2.1 Overview of Steiner's educational ideas in relation to those of others

In Stuttgart on March 25, 1923 Rudolf Steiner gave one of a series of twelve lectures on Waldorf Education and its relationship to Anthroposophy, where he said:

In previous times of human evolution, religious experience, artistic sense, and the inner comprehension of ideals still worked together in harmony. One can feel how, at that time when religion, art, and science still formed a unity, human beings felt themselves, naturally, to be likenesses or images of the divine spirit, living within and permeating the world (Steiner, 1921-22b/1996, p. 56).

Such a statement could easily lead a person to believe that Steiner's educational intention was to lead humanity back to an earlier form of consciousness, following a romantic philosophy of a glorification of past innocence, and a denial of the achievements of the modern era. As Ullrich states, "The cognitive theory of the young Steiner is at one and at the same time an ontology and a cosmogony – a regression to the premodern naïve movement of universal realism" (2000, p. 559). Academic critics of Waldorf Education can easily dip into Steiner's many works and pull up similar examples, that when seen outside of their broad context, appear to come from a movement that leads humanity backwards (Steiner, 1923b/1997; Ullrich, 2000; Hinds, n.d.).

Close scrutiny of Steiner's books and lectures on education however reveal a broad and much more comprehensive picture. Steiner showed great respect for what had been achieved by modern science and the intellectual clarity of modern thought. Yet he was concerned that success in this area had led to a trend of accepting the dominance of science and intellect over other areas where it should only have a partial place (Steiner, 1919a/1995; 1920/2001; 1921-22a/1995; 1921-22b/1996).

Look wherever you like in today's science; you will find wonderful answers to the problems of outer nature, but no answers to the human enigma. The laws of science cannot approach us. Why? Although it sounds like heresy to modern ears, whenever we approach the human being with natural laws, we must move into the realm of art. (Steiner, 1923d/2004, pp. 7-8)

To Steiner, modern scientific thinking, successful as it was, only had complete validation in the realm of the objective material world. He felt this thinking proved supremely useful in developments made in subjects such as physics, but a living organism needed to be viewed more broadly, and deeply than biological studies were prepared to reach. (Steiner, 1919d/2000; 1919a/1995; 1919c/1997; 1920-23/2007; 1921-22b/1996; 1923b/1997; 1923d/2004).

Meanwhile Freud was making headway with a science of the psyche that could have provided the connection between body, soul and spirit Steiner was looking for. However while Freud acknowledged that there was something more to the human psyche than various states of subconscious, he saw this something else as being beyond the realm of deductible logic and science, and therefore did not pursue it (Freud, 1952). But Steiner argued that the positivist surety of science needed to reconnect with the chaos of the creative arts if the human being was to be understood. Clear scientific thinking needed to connect with the fluctuating world of human creative feeling, and as such can only ever be a work in progress, for the stability of clear thinking must merge with creative movement. (Steiner, 1919d/2000; 1919a/1995; 1919c/1997; 1920-23/2007; 1921-22b/1996; 1923b/1997; 1923d/2004).

We must first begin to realise that human consciousness is an artist working creatively with matter itself; if we want to comprehend the true nature of the human being, we must acknowledge the artistic creator in each individual (Steiner, 1921-22b/1996, p. 55).

Other philosophers and educationalists also reached the conclusion that art and science needed to reconnect. John Dewey saw the artistic nature of imagination and creativity as the catalyst for uniting scientific knowledge and religious traditions and beliefs (Sloan, 2012). Sternberg, Wilber and Gardner metamorphosed the terms, but still looked to their unification as a way forward (Sternberg, 2003; Filipson, 2009; Gardner, 2011b). While a range of recent research has been conducted showing the importance of integrating art and science (Gidley, 1998; Kennedy, 2006; McCabe, Neill, Granville, & Grace, 2013; Pellico, Friedländer, & Fennie, 2009).

On the subject of religion, Steiner saw it as the process humanity needs in order to develop intellectual humility. He saw the need to push abstract intellectual conceptions back so as to find a balance between intellectual egoism, and complete acceptance, between which he believed the human being could confront the spiritual world with intellectual humility (Steiner 1919a/1995). Whitehead rejected the dualism of spirit and matter and saw the answer being the mending of the rift between science and religion (Griffin, 2012). Wilber saw their unification as one between soul and sense (Filipsone, 2009). Meanwhile a range of research has been recently conducted showing the value this union has on moral social behaviour (Boske, 2012; Missouri Alliance for Arts Education, 2010; Upitis, Smithrim, Garbati & Ogden, 2008). But unlike his contemporaries, and more in keeping with recent attitudes towards the spirit (Grace, n.d.), Steiner did not advocate a return to religious tradition or dogma in education. (Steiner, 1919a/1995; 1920-23/2007; 1921-22b/1996; 1921-22c/2003; 1923d/2004).

When dealing with the moral and religious aspects of education, we cannot draw material from existing ideologies, religious institutions, or established ethics. Our task is to reach the students' inner being so that, in keeping with their destinies, they will be able to work freely with others in the social sphere (Steiner 1921-22c/2003, p.274).

Steiner's work would appear from this to be more advanced than his contemporaries, but not everyone would agree with this. Ullrich describes his ideas as "mythological" and as belonging to the early Romantic Movement.

Like the early romantic writers, Steiner's critique of modernity seeks the reconciliation of science, religion and art – a new cultural mythology stemming from the enhancement of the thought process until it becomes the intuitive experience of original knowledge (2000, p. 560).

As shown above, Steiner called on the scientists and logical thinkers of his day to loosen their academic rigidity, and unite with religion and art, so as to humbly meet the spiritual world through creative experience. Yet critics such as Ullrich (2000), argue, that "his often strange and esoteric diction places practically insurmountable obstacles in the path of scientific and philosophical analysis (p. 555)."

Yet McDermott (1989), after making a comparison of philosophers who show the capability and willingness to penetrate others thoughts and transcend their own self-interests, drew the conclusion that; “a training in mysticism and clairvoyance might be an important preparation for philosophical dialogue (p.34).” While Laszlo (2006), points out that intuition and even traces of mysticism can be found in many of history’s great scientists and inventors.

Bruno, Galileo, Copernicus, Kepler, and Newton himself had deep intuitive, even mystical streaks. Nor did intuition lack in the giants of twentieth-century science. As their writings testify, it was a leading element in the thinking of Einstein, Erwin Schrodinger, and Niels Bohr, as well as Wolfgang Pauli and Carl Jung, to mention a few (Laszlo, 2006, p. 59-60).

However even Ullrich (2000), confesses that, all else put aside, the Waldorf school movement is highly successful, with its students demonstrating particularly good qualities. While the first Steiner school was among many private experimental attempts at education that grew out of an unsettled bed of seething politics and change after the First World War, it has survived the last hundred years and has flourished. Dahlin (2010) conducted a comparison between Waldorf and non-Waldorf students, finding that 18-19 year olds in Waldorf schools had developed far more interest and activity in regards to moral and social questions. Gidley (1998; 2002) has reported that this active interest is what separates Waldorf students from the many young people today who give in to feelings of hopelessness.

Waldorf education incorporates other aspects of Steiner’s anthroposophy as well as the bringing together of art science and religion. It takes a holistic approach, viewing the child and adolescent as an individual, as part of a community and as part of the cosmos. It is important to consider this in relationship to the theme of integrating art, science and religion for the teaching strives to appeal to the child’s body soul and spirit, and takes into consideration human stages of development over the centuries, seeing this reflected in developmental stages in a child’s development. Curriculum guidelines were given so that students could be taught subjects that reflect soul development at different stages, indications are given as to what skills are best learnt in these respective stages, as well

as indications given to the teachers as to what kind of consciousness they need to be carrying while teaching the different stages of the developing child (Steiner, 1919a/1995; 1919b/1996; 1921-22a/1995; 1923b/1997). It is therefore important for this thesis that the time periods selected for study, relate to the curriculum level and age of the students that lesson planning is intended for.

Both Freud and Piaget also saw developmental stages in child development, which dictated what could best be learnt during them (Freud, 1952; Sloan, 2012). Gardner (2011a) states that psychologists now generally accept the notion of stages of development coming at particular ages. What stands out as different in Steiner's view, is that he saw these developmental stages as a re-experiencing of an evolution of consciousness, experienced by humanity as a whole over the course of human evolution (Steiner, 1919a/1995, 1921-22a/1995, 1921-22b/1996).

This idea of an evolution of consciousness was not Steiner's alone. As Gidley points out (2007), the idea began with the Romantics and German Idealists such as Hegel, Goethe and Schelling, and was later developed by Aurobindo, Teilhard de Chardin, Lovejoy, Neumann, Bergson, Wilber and Gebser as well as Steiner.

Gebser, Wilber and Steiner all see the physical world as unfolding from the spiritual. But they differ in that Steiner sees the human being's earliest challenge as the struggle for the spirit and soul to take physical form, Gebser sees it as human being's struggle with the cosmos, and Wilber sees it as their struggle with nature. All three agree that early humans were not able to experience themselves as independent selves, and did not differentiate the earth from the sky. But while Gebser focuses on a spiritual evolution, with early man being close to original consciousness, Wilber focuses on humans' biological primitiveness and the overcoming of their lower selves (Gidley, 2007). Steiner marries both ideas describing humankind's need to overcome passionate impulses, while at the same time having original inspired wisdom. (Gidley, 2007, Steiner 1909/1972). Gebser's integral-aperspectival cultural phenomenology shares Steiner's view on the reflection of past stages of human development in the stages of child development today (Breckenridge-Watts, 2012).

As shown previously in the introduction, numerous others have acknowledged a rift between art, science and religion that needs to be reunited. But when did this split happen? How did this effect the evolution of consciousness? And what effect will mending it have on the education of the human being?

## **2.2 Art, science and religion, and their relationship to human development**

When did Science, Art and Religion part company? According to Gidley (2007), Wilber, Gebser and Steiner all viewed the development of “Western philosophy in Greece as a turning point between mythical consciousness and mental-rational consciousness” (p. 91). Gidley (2007) also points out that similar changes of consciousness appear to have taken place with Lao Tsu and Confucius, indicating that this was not isolated to Western development, and she also indicates that it is around this same period in history that we have the birth of major religions, such as Zoroastrianism, Buddhism, Taoism, Confucianism, Jainism, and Christianity. She asks if this was the point when science as a rational domain, separated from non-rational art and religion, and if this was an attempt at a rationalisation of spiritual experience which led to the formalising of religion?

Gidley (2007) goes on to say that Wilber, Gebser and Steiner all agree that this abstraction of spiritual experience into thought had a rigidifying effect that led to egoism. She states that all three see the sixteenth century as a time when spirituality and thinking completely split, and also that all three saw this as both a “downward” path, and of the development of a new stage of consciousness. However, Steiner saw this as a necessary path that humanity needed to take (1909/1972), so that it could then turn upward with the advantage of matured thinking

To Wilber, Gebser and Steiner religion moved from a picture consciousness to one of thought around the time of the Greek philosophers in the third century BC (Gidley, 2007). This suggests that religion and art might also have begun their split at this time. Art historians such as Richter (1985) and James (2001) make observations of an evolution of consciousness reflected through art, and in doing so they show that spirituality and mythic

religion was far more intrinsic in art in earlier times than was the later case. They both indicate a perfect balance of the human being reflected in the statues and architecture of Greece's golden period, which they say transformed into a reflection of egotism in the later Roman versions. They also both refer to the development of three dimensional perspective in the sixteenth century art as a reflection of a new stage in human development, where spiritual ideas affect us on less of a feeling level, and more in an intellectual way.

### **2.3 Other approaches to art, science and religion**

Steiner's practice of separating out science, art and religion, understanding each activity in relation to the human being, followed by the unification of the three in harmony, can be also seen in Ken Wilber's integral philosophy. In Wilber's view, the true, beautiful and good need to be separated out, so that contexts, cultural aspects, surface structures, and correlations with recent discoveries, can all be recognised, placed in relativity to the whole, and then become holistically integrated again (Filipsone, 2009). Just as Steiner saw the virtues of truth, beauty and goodness as linked to the domains of science, art and religion, Wilber regarded religion and science as a marriage of 'soul' and 'sense', and called for a critique of non-integrative approaches to knowledge, and advised caution using any approach that was partial, shallow or narrow (Filipsone, 2009).

Howard Gardner values a deeper understanding and integration of truth, beauty and goodness. He regards truth as the attempt to keep reviewing and updating the collective truths of humanity, along with the recognition of that different things are considered 'truth' at different times (Gardner, 2011b). In our present age, this notion of 'truth' has become claimed to a high degree by the domain of science. Scientific evidence has become the sole means through which truth is defined.

Gardner sees beauty as a recognition of our individual taste, along with an acceptance that beauty is different for others, and also changes with age (Gardner, 2011b). This is seen in contemporary arts that differ greatly from each other; and what attracts one person can repel another. Goodness, for Gardner, is related to morals and ethics. He points out how these can

change through ‘ethical conversations’, but can become fixed in others. More specifically, he associates morals with cultural and traditional communities, while ethics is associated with career paths and chosen communities. Gardner concludes that it is important for people to gather both intellectual knowledge and feeling experience, and organise these to the best of their ability whilst trying to keep in mind and sight what is most valuable, so this knowledge can be directed towards the good (Gardner, 2011b). In this regard, Gardner’s view of goodness is removed from traditional concepts of religion. However in his emphasis on directing thinking and feeling towards the good, he links the good back into the realm of will, relating it back to Steiner’s notion of religion – a striving for goodness through the will, through activity.

To Gardner an important factor in the modernising and integrating of truth, beauty and goodness is the ability to stay flexible in the integration process. He found that people were least able to adjust their views if they had adhered to them for a long time, had an emotional attachment to them, or had taken a public stance on them (Gardner, 2011b). We could link these three issues with a kind of fixed stubbornness of thinking, feeling and willing. That is a reliance on a habitual form of thinking, a clinging to particular feeling experience, or a refusal to change a direction of will for purely egocentric reasons. This also relates to Steiner’s focus on thinking, feeling and willing, whereupon he recommended a process of separating and examining these processes, before reuniting them and directing them towards a goal (Steiner 1904/1994). Gardner saw philosophy - in itself a form of thinking – as divided into three strands in an attempt to free truth, beauty and goodness from fixedness. Truth he associated with epistemology, beauty he associated with aesthetics, and goodness he associated with ethics (Gardner, 2011b).

Robert Sternberg (2003) studied another triad that can be linked to this study – that of intelligence, creativity and wisdom. Intelligence can be seen as an outcome of science, as the pursuit of truth through thinking. Likewise creativity can be recognised as the outcome of art, as beauty, experienced through feeling. An argument can be raised that creativity is not necessarily linked to the domain of the arts, but if art is defined not by its domain, but



by beauty experienced through feeling, then creativity is the outcome of art, regardless of whether it takes place in the domain of art, science or religion. Thirdly wisdom can be seen as the outcome of religion if this is defined not as a set of formed dogma, but rather as a pure and open striving for goodness through the will.

In his studies on implicit theories of these qualities Sternberg (2003), found discrepancies between their formal associated meanings and those embedded in peoples conceptions. He also found a tendency in implicit theories for descriptions of intelligence, creativity and wisdom to be towards the extreme, separate from each other, and somewhat exaggerated. However Sternberg put forward his own explicit theories where he saw the three not as isolated qualities, but integrated and inseparable. Sternberg saw intelligence as something utilised by intelligent thinking, but saw it as something needed also in creative and wise thinking. Abstract and regular familiar tasks required intelligent thinking, and these are needed to form a scaffold for both creative and wise thinking. He felt that an interaction with the environment, a particular style of thinking, and motivation was needed for creativity to take place, but that this needed to take place on a scaffold of intelligence. Sternberg does not link creativity to a feeling experience, his focus comes more from the view that intelligence, creativity and wisdom are all a kind of thinking. However Sternberg regards wisdom as a combination of creativity and intelligence directed towards some form of common good, and in this regard he links wisdom with the will.

Both Steiner and Gardner describe truth, beauty and goodness as virtues, in keeping with philosophies dating back to the ancient Greeks. Science, art and religion can easily be viewed as domains, particularly in relation to educational departmentalising. However it is clear through reading Steiner's many works that he did not see these virtues and domains as separate, but rather that he saw these domains as flexible, changing, on-going, outer manifestations, of the union between the virtues of truth, beauty and goodness, and the activities of thinking, feeling and willing. In the same way, we can view Sternberg's triad of intelligence, creativity and wisdom, as outcomes of the same unions. The ideas presented of Wilber, Gardner and Sternberg show distinct relationships with what Steiner referred to as

Science, Art and Religion. The common factor in each of these men's ideas, is the need to openly and continuously review these triads, separating them only temporarily for the sake of clarity, but more importantly, integrating them for the better effectiveness of each of the three.

In this thesis I will use the definitions given in the introduction to define art, science and religion, since these relate to Waldorf pedagogy, and the teachers' resource I am preparing is primarily for Waldorf teachers. However the definitions and the teacher's resource can be used across all learning platforms. As explained in this section, there is a need to continuously review what the terms art, science and religion mean, and this will be considered in the reflexive thinking part of the research.

## **2.4 Can art, science and religion as defined above, be taught?**

Since the Age of Enlightenment religion has been seen more and more as the enemy of objective science, while art is seen as purely subjective. With such views any integration of the three seems impossible. Yet, according to the definition given in the previous section, Steiner's anthroposophy, Wilber's integral philosophy, and Sternberg's explicit studies all stress the importance of the integration of science, art and religion in the development of the human being. Is it then possible to teach all three? And can they be taught in such a way that their integration is encouraged?

## **2.5 Science as the pursuit of truth through thinking**

It is easy to see how the philosophical approaches to science especially over the last four hundred years, are an attempt at the pursuit of truth through thinking. Our school systems are still full of teaching material and approaches which remain like relics of these eras; encyclopaedias, teachers' resources and established lesson plans are all brimming over with scientifically proven or disproven facts. While these facts demonstrate the on-going development of human thinking, can they be simply fed to readily waiting children? Not all children are readily waiting to swallow these facts. So what part does the supply and ingestion of facts have in the activity of thinking? And how does intelligence develop?

In Sternberg's (2003) study of implicit theories of intelligence he found that intelligent people were thought to have a large store of facts and language on which to draw from, but intelligence itself was the ability to reason, think logically and clearly, and to solve problems. Intelligence then, is not developed by the accumulation of facts, but the accumulation of facts can give intelligent thinking something to work with. Sternberg also found that embedded in the ordinary persons notion of what intelligence is, was the ability to be goal driven, the ability to weigh up and balance ideas, and the ability to apply their knowledge not just in an academic setting, but to be able to apply it to more practical and worldly contexts. We can see here that in the concepts held by ordinary people, intelligence has more to do with the integration of thinking into practical activity.

To Gardner (1999; 2011a) intelligence is something that acts as a precursor to actual thinking. In his multiple intelligences theory he demonstrates how certain innate tendencies make a person more receptive to developing knowledge in particular areas. For example a person with sensitivity to rhythm and pitch is more likely to respond to learning music, than someone without this sensitivity. Therefore if a class of children were all given the facts of how to read and play music, not all would be capable of achieving at the same level, those with the relative innate tendencies would achieve more easily. Supplying the facts then, has less to do with the development of intelligence, than the exposure to opportunities to develop these precursors, or innate tendencies to thinking.

Gardner (1999; 2011a) lists nine different kinds of intelligence, each with their own set of innate tendencies, and yet while strengths in these may be a natural part of a person's personality, he says we each have all of these tendencies to some degree, and they are all able to be developed. It is therefore exposure to a wide range of experiences, covering all the tendencies sitting behind Gardner's nine intelligences, that increases intelligence. Facts only have an effect on thinking when an interaction between these and intelligence has taken place.

If thinking is to move beyond intelligence and embark on a pursuit of truth, then as Steiner (1919b/1996) said, given concepts need to be open so that students can form their own

judgements. If thinking were only considered to be a memorising of facts and the simple swallowing of concepts constructed by others, then scientific fact would be scientific dogma. For science to be truly a pursuit of truth, then it must be presented as open concepts, and left to the thinking of individuals to form their own judgements.

Therefore science as the pursuit of truth through thinking, can be taught, not through the mere memorising of facts, but rather through a wide range of different kinds of experiences which develop intelligence, combined with the presentation of open concepts. Furthermore this thinking should not relate only to abstract facts and concepts, but it must be integrated with experiences that are imbedded in practical action and experience. Thinking ability can be accessed, but not through tests on memorised given facts alone, but rather from open questions that stimulate thinking with the facts, and allowing for the possibility that the student may have the genius to take established knowledge to a new level.

How can we distinguish between the memorising of facts, and thinking? The learnt facts would need to be used simply as building blocks with which to form new structures.

The structures can then be raised to a higher knowing. Steiner saw philosophy, a form of scientific thinking, as a path to spiritual freedom, where the higher thinking developed through philosophy could develop into an understanding and feeling of spiritual truth and beauty, which in turn could inspire a person to pursue the greater good (Steiner 1918/1949). This leads us back to the virtues of truth, beauty and goodness, which when related to higher philosophical thinking Gardner (2011b), associated with epistemology, aesthetics, and ethics.

## **2.6 Art as beauty, experienced through feeling**

The ability to create or be artistic has often been thought to be an innate gift, not something that can be taught. Some consider it as something that is free from logic and practicality, and simply a form of subjective self-expression for the artist, or entertainment for the receiver. However art and its outcomes, are something that has accompanied human development since Palaeolithic times, stimulating experience, transcending logic, and

often preparing new ground for scientific thought to explore. Therefore it is a necessary component for human development, inspiring thought, and providing a platform on which to reach the intangible. So can Art as beauty, experienced through feeling be taught? And can it be integrated with the teaching of science and/or religion?

The term art is often associated today with something that has become rigid. This may not be the case in areas such as dance and drama, but in painting, sculpture and architecture, what has been referred to as art, has become petrified. Even in music what has been referred to as art, has become a series of notes played according to a fixed sequence. But if we go back to our definition of art as being beauty, experienced through feeling, then art is not the rigid end result, it is the feelings produced either by the experience of its creation, or the feelings its products have on the experiencer. It is the artistic process itself – creativity.

Sternberg's (2003) implicit studies described the creative person as having imagination, inquisitiveness, aesthetic taste and a certain intuitiveness. These studies also indicated that creative people had a tendency towards a freedom of spirit, and rebelliousness towards rules, which suggested to Sternberg that the logical clear rule forming aspect of thinking clashed with the free-spiritedness of creative feeling. However in his explicit theories Sternberg found that clear thinking and all that is associated with intelligence is needed as a scaffold for the creative thinker. Thus creativity needs to be built over the process of intelligent thinking in order to produce an outcome, be it a development of scientific thinking, a work of art, or a revelation of a religious goal.

Of Howard Gardner's (2011a) nine multiple intelligences only two of the precursors to intelligence lend themselves to what is commonly thought of as scientific thinking - logical/mathematical and verbal/linguistic. However the verbal/linguistic can also act as a precursor to Art in the form of poetry or creative writing. Furthermore we can see that four of the other precursors to intelligence are also related to traditional arts - musical/rhythmic, visual/spatial, bodily/kinaesthetic and interpersonal. This could suggest that there are more intelligence precursors related to the arts domains than to science domains, which are the domains usually associated with intelligence. It could, on the other hand mean

that precursors to intelligence are not related to particular subject domains at all, but that multiple intelligences including the ones linked with creativity, are required for all subject areas. Either way, this indicates the importance of creativity for education.

In recent times many studies have been made to understand the difference between creativity or artistic tendency, and the subject domains associated with the arts. What has been found is that creativity is not limited to gifted people, but rather that all individuals have and can develop it. For this to happen it needs to be cultivated in a learning environment (Runco, 2004; Claxton, Edwards, & Scale-Conatantinou, 2006; Robinson, 2006; Csikszentmihalyi, 1999). Furthermore in studies that have looked at bringing art into learning environments that are traditionally dominated by intellectual thinking, it has been shown that doing this, increased learning development (Upitis, Smithrim, Garbati, & Ogden, 2008). However creativity has only been found to be a generalised ability to some degree, it is also dependent on skill sets that individuals have, and subjects they are interested in (Lubart & Guignard, 2004), further more Runco, (2004) relates the lack of creativity in some individuals to the inability to find a domain, or set of skills they are interested in.

Creativity, or artistic feeling is something that can be developed in schools, however it is not so much taught, but facilitated, with opportunities for artistic experience set up within the environment, and encouragement given for children and students to create their own learning challenges. (Runco, 2004; Claxton, Edwards, & Scale-Conatantinou, 2006; Robinson, 2006; Csikszentmihalyi, 1999; Gardner, 2011a). As indicated above, artistic feeling can act as a stimulant for scientific thinking, and should be integrated into subjects that work predominantly with scientific thinking as well as those domains that lend themselves more toward the artistic. Likewise scientific thinking does form a structure on which artistic feeling can be experienced and artistic activities can take place.

Another aspect to consider in the definition of art as beauty experienced through feeling, is the meaning of beauty. In many modern and contemporary arts what meets us in them is not what we might consider beautiful. Gardner (2011b), explored the virtue of beauty throughout the ages, and pointed out how this, along with the virtues of truth and goodness

have changed. He stressed the need for these to adapt, and remain pliable in order to retain their virtuousness. He suggested that classical beauty need not be the basis for the judgment of a work of art, and pointed out that the potential to induce a feeling of awe, interest or memorability, could be valid considerations for beauty. He stated that “So long as they remain open to new aesthetic experiences, adults can look forward to happy outcomes with respect to the realm of beauty”p.179. It would therefore seem by this statement that beauty is the outcome of aesthetic feelings.

Historically the difficulty in teaching creativity was around the definition of what it was to teach. In more recent times the definition of teaching has widened, and the setup of a creative environment, with opportunities for independent exploration is now included in the term. What does still remain a difficulty is teacher accountability through measuring creativity. How do teachers in the creative sector assess their students? There have been many studies done on how to access creativity, and these have over time become less and less reliant on specific domains. However while creativity can potentially be accessed, more often it is the results that are assessed, not the creativity itself (Fryer, 2012; Batey, 2012; Nelson & Rawlings, 2007). Yet accuracy of assessment does not dictate whether creativity can be taught. Assessment may not give an accurate picture of creativity, but it can show that creativity has taken place and that its teaching has had some degree of impact on learning. Conceição, Azevedo and Costa, (2009) say creativity requires sensitive knowledge of reality, that is utilised by the wealth of our senses, and includes “the ability of listening to our intuitions, fears, feelings and thoughts, seeking to eliminate each and every stereotype”(p. 1324). Csikszentmihalyi (1999), links creativity with a flow of feelings and metamorphosis of sense impressions. Rather than assessing creativity, teachers can make observations of when students display these behaviors.

## **2.7 Religion as striving for goodness through the will**

Myths and legends from around the world show knowledge as emanating from the gods. In the cross over from mythological consciousness to the birth of logical thinking,

Plato (Turley, 2014), still saw all human knowledge as a projection that originated from archetypical forms on a spiritual plane. To him the pursuit of thinking led to a recognition of the ultimate good, and recognition of the ultimate good led to a striving to help all mankind. According to Gidley (2007), it is around this time that old myth based religions formalised into many of the major world religions we have today. Religion in the form of active spirituality, or as a formalised code of esoteric beliefs, was once thought integral to the learning process. Ancient mystery schools, scholastic universities, even the public school system began as a religious incentive. But with the Age of Enlightenment religious teaching came to be in conflict with scientific development, and a separation developed. In today's Western world religion is no longer included in most schools curricula. It continues only in special character schools where parents send their children to a place where particular formalised religions that they subscribe to, form the basis of the school's ethos. But does religion need to conflict with science? Does it need to take the form of an organised dogma? And can Religion as a striving for goodness through the will, be taught in any school system without being controversial?

When Gardner (2011a) put together his multiple intelligences theory he was reluctant to include wisdom or spirituality as a precursor to intelligence, but after much work and observation he found he needed to add existential, naturalistic and intrapersonal intelligence, all of which link to tendencies traditionally considered religious. That is an awareness of individual existence as well as your relationship to the bigger picture, sensitivity, sense of ethics, sense of holism, and the ability to be self-reflective and introspective. If three of Gardner's nine intelligence precursors relate to what is traditionally covered in religion, then this suggests that children should be exposed to some form of religion in order to develop more intelligence.

Religious knowledge at least as taught in traditional religious doctrines emanates down from what is referred to as wisdom. Religious traditions are thought to bring this wisdom to the individuals who follow them, but can wisdom be sourced in other ways? Gidley (2010), suggested that there was a growing trend in religious views today to move away



from traditional notions to various forms of postmodern spirituality. She said the trend from traditional to reason was now rolling over into a value of experience and emotion. Philips defines religion as “an extrinsic organised faith system grounded in institutional standards, practices, and core beliefs, while spirituality is intrinsic personal beliefs and practices that can be experienced within or without formal religion” (2003, as cited in Zhang, 2012, p. 40). Zhang goes on to describe spirituality as broader and more inclusive of a person’s entire inner world, than religion. Grace (n.d.), explains that while all religions have spirituality at their core, their differences cause problems for a multicultural world, thus people today relate more to spirituality. Thus spirituality seems to be separating its self from formalised religion, and expanding into a pure spirituality, and therefore wisdom too, seems to be freeing itself from the fetters of formalised religion.

According to the implicit theories of Sternberg (2003) a wise person is seen as combining intelligence with sagacity. They were able to deal with various kinds of people, understand the facts, read between the lines, weigh up information, make good judgements, think long and short term, and could solve complex problems. In his explicit theories Sternberg defined wisdom as a blend of intelligence and creativity that is directed towards the common good. Wisdom could be seen as intelligent truthful thinking blended with artistic feeling for beauty and directed as active good will. Or put another way, wisdom was that which was developed out of a blend of science and art, which was then directed into action as religion.

In his modern approach to spirituality in education Rossiter (2006) identified the religious with terms such as transcendence, personal reflection, confidence in human knowing, and spiritually inspired values and commitments. In a study on adolescents about spirituality, aspects such as transcendence, traditional religious views, prayer, quest orientation and existentialist philosophy were considered of little value to students. However these students highly valued spiritual aspects such as conscious wise interactions, generosity and compassion, and the search for beauty and wisdom (Bussing, Foller-Mancini, Gidley & Heusser, 2010). Whether we use the term religion or spirituality, it would appear that the students from this survey were more interested in the striving for goodness through the

active will, or the development of virtues, and the putting of these to practical use.

While transcendence is losing popularity with young people, meditative practices were on the increase. The Center for Contemplative Mind in Society (“Contemplative Mind”, n.d.), have brought meditative practices into universities, and students find that meditation helps improve clarity of thinking, and increases creativity. Also in children’s classes quiet meditative silent times have been introduced where the children experience a feeling of being cleansed, and being able to think better.

Religion can be introduced into learning environments without the need for traditional dogma. It would also seem that not only could it be integrated with the teaching of science and art, but that it could bring about an improvement in student learning by clearing the mind and increasing creativity. Religion also provides the channels needed so that what is done as science and art can be actively put to use for the common good. However how one assesses the religious aspect of education poses problems, not because the results can’t be measured, but because religious, ethical, wise or good actions are an area in which modern Western society aspires to be free. Therefore we are left with the question – do the results of religious teaching need to be measured?

In his modern approach to goodness, Gardner (2011b), saw the establishment of ethics in organisations as a modern replacement of what existed in traditional religious conventions. He also saw the establishment of an individual set of ethics as a next step in the development of human goodness. Steiner promoted the notion of education for freedom, not as freedom of will, but as freedom of thought. In fact Steiner (1918/1949), built his entire philosophy of freedom around the theme that humankind could only be free in thought. Steiner (1921-22b/1996), did not see religious will as taught through any conventional or established ethics, but encouraged teachers to reach the inner being of the students so that they could be free to establish ethics out of their own convictions. In this manner students are encouraged to think freely, but their actions are still governed by the rules of society. This does not become a problem as long as these rules are ethical guidelines in which we all agree to live, and not hardened rules enforced by politics or dogma.

If our actions are not entirely free but our thoughts are, then it follows that some measurement of religious behaviours or results from students' study of religion does need to be measured against a set of ethics acceptable to society as a whole. This would not be a critical assessment of the student, or an encroachment of their freedom of thought, as much as a safeguard to ensure that there is not a general set of behaviours coming to students from a particular teacher or schools influence, which conflict with ethical guidelines agreed to by society as a whole. It is therefore the teacher or the school which really needs assessing so as to ensure they are meeting the inner being of the student in such a way that society's agreed general ethics are able to be recognised and inwardly developed, while allowing the students the freedom to develop their own specific ethical values around them.

## **2.8 The integration of art, science and religion in teaching**

In examining how art, science and religion can be taught it has become clear that they need to integrate in order to flourish. Gidley (2006), points out that the academic world still has a tendency to fragmentise and categorise knowledge, dividing it into disciplines, although she also says that it is becoming more aware of integral consciousness. Csikszentmihalyi (1996), stated that where domains, fields, and individual students interacted, creativity could be observed, thus indicating that it is in the weaving of art, science and religion that creativity takes place. Robinson (2011), pointed out that the school system was too linear, calling for an elimination of the hierarchy of subjects and criticised rigid timetables and the interruption of students' flow of creativity. While Hogan (2009), called for the integration of spiritual dialogues in the domain of science to increase moral considerations and create a human focus for scientific endeavours. Foucault links all this together calling for an analysis of structural and post structural constructs, pulling them apart, so that new conscious constructs can be formed in keeping with society's present needs (Foucault, 1969).

### 3. METHODOLOGY

#### 3.1 Methodology background

This study demonstrates one teacher's approach to the unification of Art, Science, and Religion, inspired by Rudolf Steiner's anthroposophy as the foundation behind Waldorf Education (Steiner, 1904/1994, 1919a/1995, 1921-22b/1996; 1919c/1997, 1923b/1997, 1924a/1997, 1919d/2000, 1920/2001, 1923d/2004, 1920-23/2007). The research consists of a creative artefact and an exegesis. The artefact is a teachers' resource book for teachers of 14-16 year olds in a Waldorf setting. The subject of the book is 'Light and Colour.' The exegesis explores the background and the process of creating the teachers' resource. This includes research which assesses the following questions, analysis of which, provided the ground to select information to include in the resource book.

- *How can a union of Art, Science and Religion be achieved?*
- *How can this process enable a person to cross subject domains in their learning?*
- *Does, and to what extent does crossing subject domains lead to higher levels of knowing?*

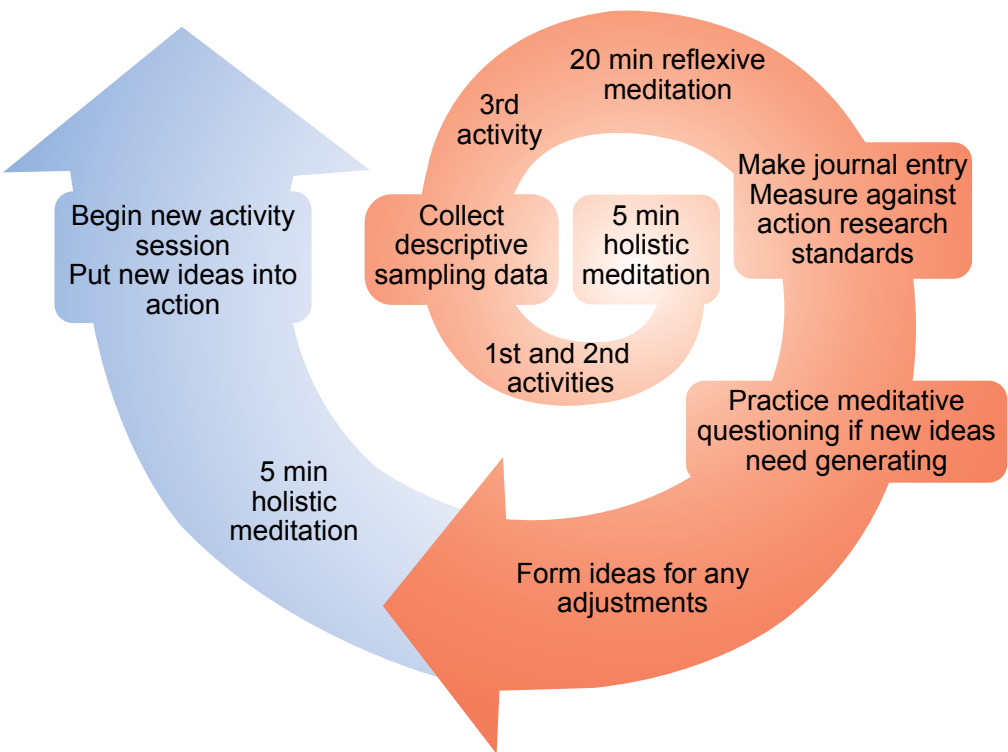
Wherever I have used the term 'domain' I am referring to an overall subject area of either art, science or religion. When I talk of 'crossing domains' I am referring to a thought process which begins in one domain, such as art, and crosses to another, such as science. Where I use the term 'higher levels of knowing' I am referring to thought processes which go beyond surface observations or experiences such as ethics, aesthetics, epistemology in regards to thinking, a flow of feelings, a metamorphosis of sense impressions or a feeling of knowing in regards to feelings, and an intention to accomplish a virtuous goal in regards to will. These descriptions are a simplification of what has been presented in the literature review where the combination of art, science and religion in relation to teaching was discussed, they are simplified for use in the analysis stage of this research.

The methodology used in this research was a combination of recognised methodologies, assembled to form a research process that reflected the philosophy behind Steiner education.

This combination was an attempt to form research in a manner that respected both anthroposophical values and academic rigour. This was of particular importance in my research, since I view myself as both a student capable of academic study and as mentioned in the introduction, as an artist, a teacher and as an anthroposophist. Therefore my values include respect for an integrated, holistic approach to knowledge, creative knowing as well as clarity of idea development, and openness to change, seeing knowledge as something that is in a constant process of metamorphosis adapting to changing contexts, which I consider to be spiritual as well as material. The methodology I used strives to meet all these aspects of my epistemology.

The basic framework of the methodology is action research, but this is blended with auto-ethnology, underpinned by Rudolf Steiner’s indications for meditational research. The research involved assessing my own practice of teacher preparation, which took place over a period of one month, and involved on-going creation, assessment and adaptation of lesson plans to assess the running of activities within a classroom, and appropriateness for the teachers’ resource book. In this respect the research can be regarded as action research. Below is an ascending spiral diagram showing the action research process I used, with methods incorporated from auto-ethnology and meditative processes.

**Figure 1. Action research ascending spiral diagram**



However action research would also require that I develop knowledge through interaction with others (McNiff, 2013) and, while I considered the effects of these lessons on a particular group of students, I did not include lessons with them as part of this research. Since I was doing this research only on myself, I borrowed aspects of auto-ethnography to strengthen my methodology.

By incorporating auto-ethnography I was able to research myself as a subject. It also allowed me to examine “multiple layers of consciousness” (Ellis & Bochner, 2000, p. 739), and make connections between these and the potential experiences of the students in my class. Guidelines and methods used in auto-ethnography ensure that considerations were made for the validity, the reliability and the generalisability of the gathered research (Davis, 1999; Ellis & Bochner, Ellis, 2008). I incorporated some of these guidelines and methods into my action research process to improve the validity, reliability and generalisability of my research, which in action research was usually achieved through interaction with others (McNiff, 2013).

For auto-ethnography to be considered valid the researcher needs to be a genuine living and working participant in the area being researched (Davies, 1999; Ellis & Bochner, Ellis, 2008). I am a Waldorf teacher researching my own teaching practice. I incorporated a form of introspection developed by Russel Hurlburt called ‘descriptive experience sampling’ to ensure the reliability of the data collection (Wooffitt & Holt, 2010). In this way the data gathered was prevented from being constructed to fit prior ideas. Reliability also needed to be considered when analyzing the data, I used deductive ‘constant comparison analysis’, also known as ‘coding’ (Leech & Onwuegbuzie, 2007), to provide clear results on which to do the evaluation, and ‘classical content analysis’ to measure the extent of possible connections in different combinations of activities. Generalisability was a problem in regards to how my experience would differ from that of my students. However it was not my expectation that my students were able to take in every learning aspect that I did. The assumption here was that, the greater the number of possibilities for making connections, the more likely it would be that students were able to make some themselves. The research

did not rely on my students repeating my internal experiences exactly, but what could be generalised was that, more connections I made, the more possibilities there would be for my students to make connections of their own. This assumes that with my knowledge and experience I have a greater capacity to make connections. How these methods are used is explained in full in the data collection and analysis sections.

In respect to maintaining research hygiene, and avoiding self-indulgent research, which Davies (1999) warns can be a weakness of auto-ethnography, I practiced a short holistic meditation before each of the research gathering sessions. I also incorporated other forms of meditational practice into the research cycle as indicated in the diagram above, and described in the section below.

### **3.2 Meditative practice in relation to Steiner Education and this research**

A vital aspect of Steiner teaching practice is that of meditation. In his lectures on education, Steiner recommends that teachers meditate on both their students and on the lessons they are preparing for them (1919d/2000). In this way they can create a synchronised series of learning experiences that stimulate the students on an inner as well as intellectual and practical level. For example in ideal circumstances the lessons should tie in with the students biological development, there should be a breathing and digestion of learning experiences, and there should be interconnectedness with learning happening in other domain subjects, as well as a consideration of the students as a group of individuals with particular interests and needs (Steiner, 1919d/2000; 1919a/1995; 1920/2001; 1920-23/2007; 1921-22b/1996; 1923b/1997; 1923d/2004; 1924a/1997). That is a lot to consider, and all these considerations need to be integrated in as best a way as possible. Therefore it would never be enough to simply draw up a list of considerations and tick them off as you incorporate them into your teaching. Rather what is needed is a meditative approach to simulating this information, so that a creative solution can manifest.

Meditative practice is not usually used in academic research as it is not recognised as a methodological scientific approach. However Wildman & Miller (2012), produced an academic article showing how exoteric and esoteric research could support each other. They

explained that while exoteric research could hypothesise, test, observe, calculate statistics and draw conclusions, esoteric research could acknowledge emotional experiences, personal developments, widen rational thinking, reveal hidden constructs and integrate inner and outer. The descriptions below, of meditative practices I use show how these practices can be used to deepen and broaden the scope of the action and auto-ethnography research explained in this chapter.

There are a variety of different approaches to meditation and many require preparatory work; for Steiner, preparation and a more scientific approach to meditation was important. He introduced preparatory exercises for hygienic thinking and focused on a particular question rather than a complete surrender as in some approaches, as well as encouraging researchers to revisit their meditative questions from multiple perspectives before forming any conclusions (Steiner, 1918/1949).

Today the practice of meditation is growing in popularity. Amherst physics professor Arthur Zajonc of the Mind and Life Institute linked leading scientists with practising Buddhist monks to find a way of developing and integrating both practices (“Dialogues”, n.d.; Schmidt, 2012; Zajonc, 2009). Their work has led to a wave of new meditational practice places being set up in universities throughout America, and these are spreading to other parts of the world (“Contemplative Mind”, n.d.; Palmer, P. Zajonc, A. & Scribner, M., 2010). In his book *When knowing becomes love: Meditation as contemplative inquiry* (2009), Zajonc suggested guidelines for meditative investigation. Foucault also valued the ability to detach oneself, focus on a thought, and reflect on it to increase knowledge (Wain, 2006). However like Steiner and Zajonc, he also saw the need for “rules of conduct or principles which are at the same time truths and regulations” (Wain, 2006, p.20).

What Steiner and Zajonc agree on in regard to mediation, is the need for guidelines, or processes which safeguard the hygiene of meditative practice. In university research, methodologies incorporate guidelines that provide this hygiene. Methods used in auto-ethnography such as ‘reflexivity’ and ‘systematic sociological introspection’ (Ellis & Bochner, 2003; Ellis, 2008) involve research approaches which are similar to some of the meditational processes described by Steiner and Zajonc. Likewise the guidelines are similar to those I usually use in meditation.



In this research I have used three different approaches to meditation, all of which were indicated by Rudolf Steiner (Steiner, 1909/1972, 1904/1994, 1921a/1996, 1919d/2000). One way, which I have referred to as ‘holistic meditation’ was done for hygienic purposes to try and clear myself of any personal ambition, and biases, and prepare myself for an open-minded process that was open to various perspectives. To do this I first focused on the students I taught who were of the age range the exercises were being designed for. Up to this point what I did is similar to what is done in ‘systematic sociological introspection’ (Ellis & Bochner, 2003; Ellis, 2008). However I then tried to expand my perception to envisage a world consciousness, before I focused on a simple moving image. I visualised a white circle with a black dot, which gradually grew to become a black circle in which a white dot appeared, then growing and taking over the black. I continued imagining the cycle of changing circles until my mind became still. Then with a still mind I waited to see if an imaginative picture or idea manifested that seemed to come from outside my own ideas or concerns.

This could be viewed as inner hygienic cleansing, whereupon I became aware of emotional factors, or rigid thinking patterns that stood in the way of truthful observation. I also felt that I had and checked with a spiritual authority that my overall activities and intentions had validity from a holistic position, and put off my research when I felt this was not the case. I did this meditation before each set of research-gathering exercises, it took an average of five minutes and in most cases nothing manifested. Where something did I took this into special consideration. An example is described in the research chapter.

I used a second approach which I have referred to as ‘meditative questioning’, when I had a specific question which needed solving. I focused on a particular question in relation to my teaching practice, then stilled the mind again and waited for an answer such as an image, a feeling, or a general knowing. If this process was done before sleeping, then the answer could come in the morning on awakening, or when I first approach the problem that was questioned. I used this approach when I needed to generate new ideas such as changing approaches in the art work to suit the students better. I did not use this approach in the research sessions, but before sleeping in the evenings. The process required me to think

about the problem with as much detail as possible, and the time it took could range from five to twenty minutes depending on how detailed the problem was. The imaginative results usually came when I viewed the problem the following day, although sometimes the answer would come on waking in the morning. This is an approach I have used throughout my career as a designer. I have always found that my best designs came after using this process.

The third meditational approach I used is something that could be likened to methods used in conducting action research and auto-ethnology. I have referred to this as reflexive meditation; within the anthroposophical movement it is called Goethean observation. This is where I focused intently on an activity I was doing, blocking out all outer disruptions, considering aspects of the activity from multiple angles, considering variables, consciously tracing concept links, and following them back to prior stages, as well as projecting them forward and considering new possibilities. The cognitive aspect of this kind of meditation is the same as reflexive thinking as used in both auto-ethnology and action research (Davies, 1999; Ellis & Bochner, 2000; Ellis, 2008). However when I did this kind of research I also paid attention to feelings and physical actions and, when this was included, the process was better compared with methods of introspection, where such thoughts are caught and recorded before they can blur into obscurity (Wooffitt & Holt, 2011; Ellis, 2008). I used this form of meditation after each research session, spending twenty to thirty minutes including writing a short description of any relative observations in my research log.

### **3.3 Plan of the research study**

#### **3.3.1 Establishing what material to use in the research**

The first step in the execution of this research was to select a body of material on Science, Art and Religion, that could be used in the main research process, and from which material for the teacher's resource book would be assessed and evaluated. I chose the seventeenth to nineteenth centuries as a focus area for the study of light dark and colour, and prepared material that would be taught to students in the age range of 14–16 years. The age range of the students related to the timeframe I had selected to study in history according to the

Steiner curriculum (Lindenberg, 1989/2004), which had the added benefit of helping to contain my study focus for this thesis.

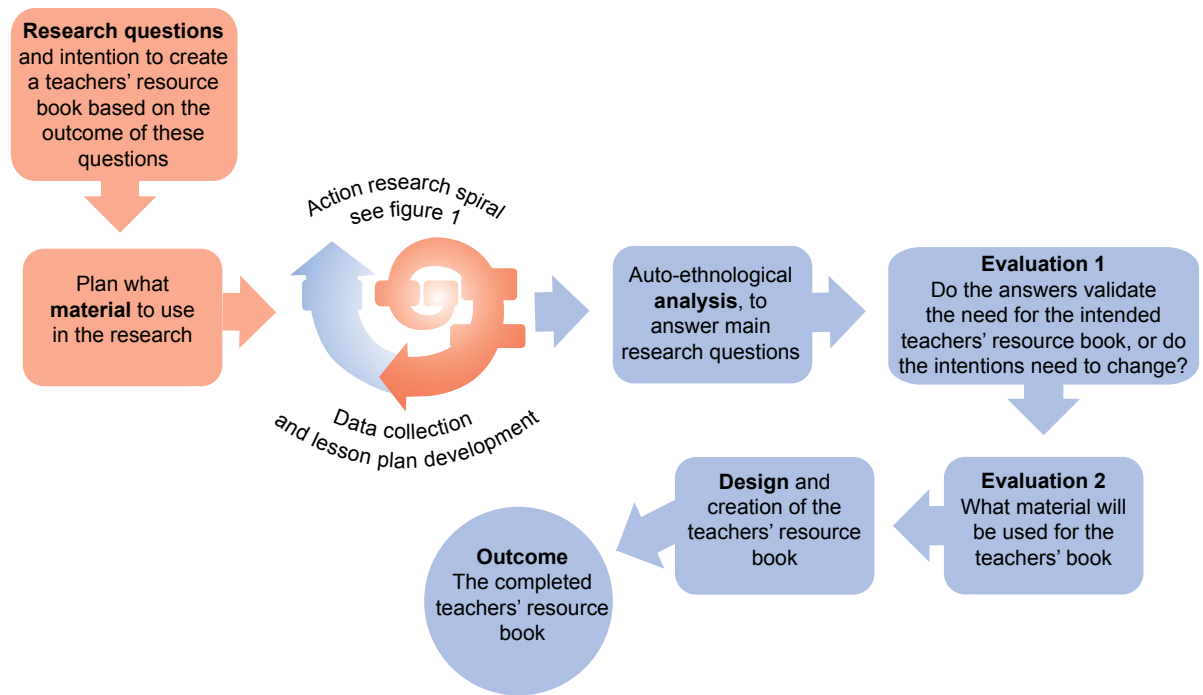
Looking at the main scientific developments in light from the seventeenth to nineteenth centuries I found that doing justice to all the relevant experiments of these scientists was going to be too extensive for this research. I narrowed the criteria to developments in light and colour, and decided to focus on the experiments by Newton and Goethe. Using Newton's book 'Opticks' and Goethe's book 'Theory of Colours' I decided to work through their experiments (Newton, 1669/2010; Goethe, 1810/1970). There were too many experiments to research, so I eliminated Newton's experiments which did not pertain to colour, and those where obtaining the materials would be too difficult. I also decided to leave out Goethe's propositions, as these correspond more with lessons given to older students in the Waldorf School. Assessing what was left, I estimated that these experiments could be done in twenty-four one-hour sessions.

I then researched prominent theologians, ethical philosophers, poets and writers who wrote in the time period from Newton to Goethe, gathering a collection of their written works. From there I searched these works for the word 'light.' I disregarded any use of the word that was not descriptive, and extracted quotes incorporating every descriptive use of the word. I then compiled pages of these quotes to be used in the research process (Appendix A).

Next, I looked at well-known art works from the same period, and looked for themes in their treatment of light and colour. I then selected works that best illustrated these themes (Appendix B). My intention was to create a series of artistic activities based around these art works, which would be created and executed in a one-hour session following each of the science sessions.

I gained access to the science equipment needed for the experiments, as well as a range of art materials and equipment I worked at. I used my own digital camera to photograph the activities, and performed the activities in my home. As a graphic designer I had the computer programs and the expertise to put together the teachers' resource book as a final practical outcome of the research.

**Figure 2. Overview of whole research process.**



### 3.3.2 Collecting data

The data was collected during a four-week period over the Christmas break. I undertook one three-hour session per day, from Monday to Saturday during this month. Each session began with a short five-minute ‘holistic meditation’ as described in the introduction to this methodology, as inner hygiene and to prepare myself inwardly for the research session. This was followed by three activities, through which ‘descriptive sampling’ (Wooffitt & Holt, 2010) was used to collect data. To do this, I used a timer set at fifteen-minute intervals. Every fifteen minutes I recorded in descriptive form my experience immediately before the alarm went off. This could include physical experiences, emotional feelings or threads of thought. A photograph was also taken after each report was made, and these were later coded to match with the reports. Some of these photographs were later selected for use in the teacher resource book.

The first of the three daily activities was from the domain of science. I performed one of the twenty-four sets of experiments previously mentioned, which also involved some reading. This took approximately an one hour.

The second activity was from the domain of art, where I created exercises based on the

sequence of paintings mentioned. These exercises involved the themes of light and colour within the selected works. While some consideration of what form these exercises took inevitably happened between sessions, the lessons were mostly spontaneous and open to creative change. These sessions took one hour, and due to the nature of the subject, some activities needed to be continued in the following day's art session.

The third activity was from the domain of religion. I browsed through the book of quotes I had compiled to see if one resonated in some way with the activities or experiences I had just done. I then contemplated this quote. If I could not decide upon a quote, I contemplated why not, or some other aspect of this process. This activity took half an hour, twenty minutes of it involved what I have described earlier in this chapter as reflexive meditation.

I then spent the last twenty minutes writing in a journal. First, I would date and code the recorded activities with the photos taken. I wrote down observations made of the activities, and used a reflexive approach to consider and record any observations about the three sessions which might be useful to support the interpretation of the collected data later. I also used this time to document and analyse the activities against a set of standards (see below), for the purpose of making improvements, and assessing the appropriateness for the class of students I had in mind, as well as for the selecting of material for the teachers' resource book.

### **3.3.3 Analysing data**

The first form of analysis used is in the form of action research where I used reflexive thinking and analysed the activities used against a set of standards.

The standards are:

- *How well do the practical activities work?*
- *How can the practical activities be adapted to work better for this class?*
- *Are there in improvements in the way the practical activities are working?*
- *How relevant are these activities to the overall lesson sequence?*
- *To what extent do these activities differ from previous ones?*

This process was recorded along with the descriptive data in a journal. The objective of this process was firstly to make improvements to the way the activities were done, and secondly to provide analysis on which evaluation for suitability for the resource book could be made. The first three standards relate to improvement in practice. At a later stage, where activities have been chosen to be put into the resource book, but an improvement of the practice of a specific activity was needed, that activity may have needed to be repeated and re-photographed. The last two standards helped with the evaluation for the selection of activities included in the teacher's resource book.

Constant comparison analysis (Leech & Onwuegbuzie, 2007) was used to provide answers to the main research question of if and how a union of Art, Science and Religion could be achieved. As well as whether this process enabled a person to cross subject domains in their learning, and if so, whether this lead to higher levels of knowing. This process related less to action research and more to auto-ethnology, as it has more to do with analysing the inner experiences of the self in relation to a larger context. To do this data was used from the descriptive experience sampling, which was marked if and where the data matched a set of deductively established themes. Information developed in the literature review regarding what is Science, Art and Religion, has led to the development of these themes.

These themes were:

- *Has doing an activity stimulated me to think about light and colour?*
- *Has doing an activity stimulated me to feel experiences in relation to light and colour?*
- *Has thinking about the subject inspired me to do the activity better?*
- *Has having feelings about the subject inspired me to do the activity better?*
- *Have I crossed the subject domains of Art, Science and Religion, through the process of thinking, feeling or willing?*
- *Has the crossing of subject domains led me to heightened thinking, such as the consideration of ethics, aesthetics or epistemology?*

- *Has the crossing of subject domains imbued me with deeper creative experiences, such as experiencing a flow of feelings, a metamorphosis of sense impressions, experiencing a sense of knowing through feeling?*
- *Has the crossing of subject domains inspired me to set my will to the accomplishment of new virtuous goals, such as those that relate to truth, goodness and beauty?*

Finally, a third form of analysis was used to extend the information gathered from the constant comparison analysis. Leech & Onwuegbuzie (2007) refer to this as classical content analysis whereby the occurrence of the above-established themes were counted. The number of times a particular theme appeared could be related to lesson domains and other patterns that appeared through the analysis.

### **3.3.4 Interpreting and evaluating of data**

The first form of evaluation was in the action research of the lessons themselves, in relationship to practical improvement, to the flow of the overall lesson, and the needs of a particular class of students.

The second form of analysis mentioned above used constant comparison analysis and was used initially to evaluate answers to the main research questions given at the beginning of this chapter.

The third form of analysis mentioned above using classical content analysis, was then used to establish which lessons or groups of lessons best inspired higher levels of knowing. The assumption was made that higher levels of knowing could be achieved.

The results of the evaluation based on the classical content analysis was then crossed with the analysis from the action research to evaluate which were the best lessons to include in the teachers' resource book. As an outcome of this evaluation some lessons needed reorganisation before being included in the book, as lessons that inspired high levels of higher knowing, did not necessarily meet high standards of practical appropriateness. In

which case more practically successful aspects of similar lessons replaced impractical ones, while the aspects that inspired higher knowing were maintained.

The ‘meditative questioning’ approach mentioned in the introduction to this methodology was then used to gain new ideas around how to approach these lessons. The action research process mentioned in the collecting, analysing and evaluation of data mentioned above was then used to reassess any repeated activities for inclusion in the teacher’s resource book.



## 4. RESEARCH

### 4.1 Introduction

A combination of data gathering techniques and analysis strategies were used in this research in order to create lesson plans and data, to answer the main research questions, and to design and create a teachers' resource book, (see overview diagram in the methodology chapter). The research falls into three sections

- *Lesson plan development research*
- *Answering main research questions*
- *Design and creation of the teachers' resource book*

While the gathering of data for all three stages could take place at the same time, each stage of the research needed to be reviewed, analysed and discussed before the next stage of analyses could take place. Analysis of stage two worked with the outcomes of stage one, and the design of stage three drew from the outcomes of stages one and two. For this reason three chapters on research with titles taken from the sections indicated above, will follow this introduction to the research. Each chapter will include its own review, analysis, and discussion.

### 4.2 Lesson plan development research

#### 4.2.1 Review

The action research (see diagram in the methodology chapter) formed the basis for the data. It involved the creation of lesson plans where the domains of art, science and religion could interrelate around a common theme.

The original estimate of the number of sessions needed was twenty-four. This was based on the need to cover all the selected science experiments. It was always my intention to work

the art and literature in to fit with the science, since the number of science experiments was finite, and the availability of suitable art and literature expansive. However the number of sessions worked out to be less than originally intended, due to more science activities being done per session than anticipated. This in turn brought down the session number needed for the research to be completed. The estimated twenty-four sessions were reduced to sixteen actual sessions.

### *Action research of art activities*

For the most part the artistic exercises worked well, but during the research I repeatedly considered the different ability levels of students, and how the work I was doing was for the higher ability levels. This can be seen right from the beginning of the action research process on day 1, 2 and 4, however on day 5 (see appendix C) an art task had been modified and was shown to be suitable for students of all ability levels. This pattern continued, for by day 6 (see appendix C) I was back to needing to think of more simplified tasks for students with less developed abilities. After considering different projects for students with different abilities, I discovered that simpler activities could be achieved by isolating a part of the overall task, and that this would work for students of lower ability. This would still provide an adequate lesson to work alongside the science and literature, provided an appropriate part of the picture was chosen. For example students could work on a large blown up section of the helmet in Rembrandt's 'man with the golden helmet' and this would work well for students with less developed ability, while more skilled students could work on the whole painting (see action research day 7 appendix C). Yet both tasks would achieve a satisfactory link with the theme of reflection. I recorded in the action research which parts of the various paintings could be used in this way after observing, through the action of creating them, which parts resonated most strongly with the science, literature and subject of light and dark.

Some of the pictures I had selected to study were too complex for even skilled students to create. I had selected these because of their approach to light, dark and colour rather than appropriateness for students to copy. So I took the main factors being considered in these

works, and created simpler pictures, using the same factors. This brought the skill level required down to a comfortable but still challenging level for the more adept students, and again, areas of focus were picked out for enlargement, for the students with less ability. An example of this can be seen in the teachers' resource book, where the original painting is shown, and a simplified one is created for the students to follow (see page 30-31 of the teachers' resource book).

The development of skills worked well from one picture to the next. There was a gradual increase in skill level, not only with the understanding of how light, dark and colour were utilised, but also with the range of media used. This can be seen by looking at the sequence of entries under the action research question 'Are there improvements in the way the practical activities are working?' (appendix C). I began with a simple pencil sketch, a medium and style that in my experience most students seem comfortable with. The next exercise used coloured pencil for light areas, again a medium I have found students are comfortable with. Then I introduced oil pastels which I anticipated would introduce a challenge to the students, and force them to bring in strong areas of intense colour, creating balance with the soft light areas. I followed this with coloured chalk pastels, which I have found offers a good stepping stone into working with oil or acrylic paint. The students need to understand blending and layering, but they would not yet need to mix specific colours, or control brush strokes. Next the students would be introduced to colour mixing, brush use, consistency of paint, and other techniques needed for acrylic work. Then in the last work they would combine all these skills to create a layered watercolour. (See the finished teachers' resource book page 60-66)

Whilst working through this process it became clear that the art works were taking more time than the science activities, and so three pictures were left out. Wright's 'Experiment with an Air Pump' offered little more in its use of light and dark than covered in the previous paintings. The painting is interesting from a subject perspective, but it would be very complex to paint even a small section. I decided it would be fitting to show students this work, but not to get them to work from it. I decided that David's 'Oath of the Horatii'

focused more on composition than the subject of light and dark so this too was left out. And since the science experiments ran out while completing one Turner painting, enough could be learnt from this, a second one was not needed.

### *Action research of science activities*

The science experiments were much more temperamental than the art activities. I expect my experience as an art teacher helped the selection of art activities to flow more easily. Some science experiments were easy to set up, and worked well, but others posed problems. In some cases the setup was very difficult to achieve, but the results were good and clear (see days 2 and 3 of action research, appendix C). In others the results were unreliable and couldn't be achieved every time (see days 7 and 11 of action research, appendix C).

Many of the experiments repeated the same setup. This gave ample opportunity to try out simpler ways of creating these setups, until a satisfactory one was found. For example the problems found on days 2 and 3 were solved on day 4 with use of a torch (see appendix C). When a straightforward set up was found, that also produced clear reliable results; this was noted in the action research log (see days 5 and 6 appendix C). This analysis provided the information needed to select appropriate activities for the teachers' resource book.

Since the same set up was used for multiple experiments, they did tend towards the monotonous. Newton was particularly meticulous with his coverage of experiments, but while this may have been good science, it was likely to pose problems in holding the attention of teenagers. Therefore I decided a smaller selection would be necessary for the teachers' resource book, and took notes on which experiments stood out the most, so as to later aid the selection process. In some cases I re-tried an experiment from one activity, with the simplified set up from another (see days 3 and 4 appendix C). And in many cases these were the activities later selected for the book.

Not all the experiments had relevance for the art task being done in that same session. In many cases I found myself relating the work to other art tasks, such as on day 13 where I made the comment that the painting and literature related to each other, but the science

related more to the previous art activity (appendix C). I noted where this happened, and which tasks the work related better to, in the action research log. This was later used to reorder the science tasks so as to align better with the art and literature.

In this research I did Newton's experiments first, and followed the order he had set in his book. Then I worked through Goethe's experiments also initially following the order of Goethe's book. It was noted while doing this, that it was not necessary to follow these orders. In some cases Newton's and Goethe's work related to each other, and in retrospect I thought it would have been better to run them together, or show one directly after the other. In other cases it was noted that while the art tasks were following an overall logical sequence, in time, understanding of light, dark and colour, and practical skill level, the science tasks over all were not restricted to a particular order (see day 9 appendix C).

The process within each science experiment required a sequence. And there were sets of experiments that needed to be in sequence. But in many cases the entire sets of experiments did not need to follow any logical order in relation to another entire set of experiments. Only occasionally did an overall sequence need to be considered. This meant that if the relationship between art science and literature were to be reordered, it would be easier to order the science around the art, rather than the other way around. Notes were taken in the action research log, where the science might relate better to a different art task, or piece of literature, and this was later used in the reordering of the science work, for use in the teacher's resource book.

### *Action research of literature*

Since the literature was picked out after doing the art and science activities, and the choice was based on what related to the activities just done, it was inevitable that every piece of literature would either relate to the art, or the science. However in some cases it did not relate to both, or it related to one, and only generically with the subject of the other (see day 11 appendix C). This was noted in the action research, and was later taken into consideration when re ordering the work for use in the teacher's resource book.

#### 4.2.2 Discussion

The main purpose of this section of research was to develop lesson plans for the teachers' resource book, and produce data that could be used for the rest of the research. The practical aspect of this was achieved quite successfully, but improvements did need to be made as the process progressed. Throughout the research I noticed several themes reoccurring around the concentric circles of the action research process, which were worked on as part of the process, and described in the research review above. However to ensure that I hadn't missed anything, once all the research was written up I used constant comparison analysis (Leech & Onwuegbuzie, 2007), a form of coding, to see what repeating themes stood out, and to see if these matched those covered as part of the action research process. The colours green, orange, blue and purple have been used to highlight the four separate reoccurring themes in the research log (see appendix C)

The main themes that came up were:

1. *The need to simplify artwork for students with less developed abilities.*
2. *The need to simplify set up of experiments*
3. *The need to limit science experiments to those that work well, and are most relevant.*
4. *The need to re order activities for better consistency between art, science and literature.*

As described in the research review previously, simplification of the art works and the setup of experiments was made within the action research cycle. This was not surprising in regards to the science experiments as in many cases I was doing these for the first time, and many adjustments needed to be made. In regards to the art I noticed a surprising pattern; I had a tendency to create art projects that were tailored to the needs of more skilled art students, and didn't immediately consider the needs of the less abled ones. This was an interesting observation to make, as it reflected a flaw in my own teaching practice. One that needed to be overcome for the teachers' resource book as well as my own practice.

Adaptations were made, and notes were taken on this for use in the selection of material for the teachers' resource book.

Notes were taken in regard to which science experiments worked well, and which were most relevant. These were later used in the selection of experiments for use in the teachers' resource book.

Notes were also taken on which activities related best to which. But a reordering of activities did not take place within this part of the action research cycle. It was after the completion of the research, when contemplating it using a meditative reflexive approach as well as considering the action research outcomes that I made the decision to reorder the science experiments and literature quotes to better match the artistic process.

While having a theme of focus ensured that there was some relationship between the subject domains, the Action research revealed how Art, Science and Religion could be unified more specifically. This was another surprising result, as I had thought that simply lining up the activities and around a common theme would be enough to create connections between the subject domains. However the action research indicated that more distinct links would be beneficial. More work needed to be done on this, but the action research provided data that could be used in conjunction with other methods of analysis to improve the order of the activities, so that a more specific three-way marriage could be achieved between the three domains.

Thus the action research did more than simply produce data, it also provided one answer to the main research question of 'How can a union of Art, Science and Religion be achieved?' As well as this it brought to the fore a way in which that union could be improved.

### **4.3 Answering main research questions**

Having developed a series of art, science and religious lesson material around a common overarching theme, I had overcome issues and discovered that the lesson material would work better if reordered. However I had only loosely answered one of the main research questions. The next stage of the research was to use the descriptive sampling data taken

during the action research cycle to answer these questions, and build on the research outcomes discussed in the previous section.

#### **4.3.1 Review**

1. Using constant comparison analysis where no themes had been prior deducted (Leech & Onwuegbuzie, 2007), I was able to go through the descriptive sampling data recorded in the research and look for chunks of information, which created reoccurring themes that related to the research questions. The reoccurring themes that presented themselves most numerous were clearly related to thinking, feeling and willing. In the research log these have been highlighted in yellow for thinking, blue for feeling and red for willing (see appendix C).

Most numerous were themes to do with thinking, such as ‘I thought’, ‘I wonder’, ‘I observed’, ‘I concentrated on’, etc. As pointed out in the literature review, thinking is related more to science, than to art or religion. This theme therefore can be related to science. Yet the theme occurred throughout the research data, and appeared in art and religious activities as well as those of science.

The next most reoccurring theme to appear related to feeling. Phrases appeared such as ‘delightful experience’, ‘filled with delight’, ‘joyful experience’, ‘intense satisfaction’, as well as the reoccurrence of the word ‘feel’. The literature review points out that feeling is related more to the arts, than to science and religion, but feeling themes appeared throughout the different domains. However they occurred the least in relation to the science experiments, and more often in relation to art or the religious literature.

A theme that related to willing also appeared. Themes such as ‘I tried’, ‘I want to explore’ ‘I will complete’, ‘I decided to create’ etc. The literature review linked the term will more to religion than art or science, however these themes appeared throughout the research. They did in fact appear more frequently in the science and art data, however I suspect that this was due to these both being based on activities, which in themselves relate more to will, than the reading of religious literature.



What this showed was that thinking, feeling and willing were not restricted to particular domains. But it suggested that thinking was more dominant when there was something to question, feeling was more dominant when sympathies and antipathies were evoked, and willing was more dominant in activities that required something physical to be done. Thinking, feeling and willing were therefore quite unified in each of the domains of science, art and religion. Science, as a search for truth through thinking, could appear not only in the domain of science, but also in art or religion. Art as a striving for beauty through feeling could appear in any of the three domains. And religion as a striving for goodness through willing could appear in any of the domains. This suggested another answer to the question;

- *how can a union of art, science and religion be achieved?*

Namely, that the three always appear together in any domain where thinking, feeling and willing take place.

2. Another theme to occur in the constant comparison analysis (Leech & Onwuegbuzie, 2007), was a theme that demonstrated the crossing over of ideas. These are highlighted in magenta in the research log (appendix C). Phrases appeared such as ‘reminded me of’, ‘this is similar too’, ‘this is like’, ‘this triggered’ etc. These phrases suggested a crossing over of ideas, and they appeared frequently throughout all the data, across all three domains. They suggested that a crossing of domains might have been achieved. But it is possible that an artistic notion was similar to another artistic notion, and likewise with the other domains. The only way to be sure that a crossing of domains actually took place was to read the data in relation to these themes. Further analysis was therefore needed to identify when subject domains were actually crossed.

Following the indications given by Leech & Onwuegbuzie (2007), I set prior deducted questions, based on information presented in the literature review (see methodology page 54) These questions were created to help clarify answers to the main research questions, utilising the research findings so far in relation to thinking, feeling and willing. Each of

these prior deducted questions was given a code. That code was allocated to a block of information, if that block of information revealed a 'yes' answer to the question. There were 16 sets of research, with each set of research consisting of nine blocks of information that were subjected to this analysis. In each set there were four blocks on the science activities, which had been taken at fifteen-minute intervals. Four blocks on the artistic activities, also taken at fifteen-minute intervals. And there was a ninth block of information based on the reflexive thinking after reading and selecting a piece of literature.

Chunks of information that were able to determine the themes of thinking feeling and willing in the non-deducted Constant Comparison Analysis, were able to be looked for to help answer the more specific prior deducted questions. However these were now assessed in relation to the content to see which subject domain they referred to, and in relation to which subject domain they occurred in. For example:

### **Science Experiment Day 8 (3rd 15 mins)**

Looking at the black and white images supplied through a convex glass and pulling back so they were unfocused created a slight effect of reddening and blueing along the edges. This reminded me of the sfumato effect in painting and I wondered if blueing and reddening the edges could be used to do this in art. The overall effect was not spectacular, but looking through the prism there was a distinct blueing where white moved down over black, and reddening where black moved down on white. This was spectacular. I began to think about all the rays being drawn in and absorbed by black and reflected by white, and that the refraction was showing me the individual rays or colours.

The above example represents one block of information. It is an activity. The term 'think' is highlighted as part of the Constant Comparison analysis described in the last section. Reading the context in which this word is used, I was able to provide a clear yes to the question; has doing an activity stimulated me to think about light and colour? The data block was then coded with a yellow square to represent a yes to this question.

The term 'This was spectacular' had also to be highlighted. This represented a feeling theme. Reading the context in which this phrase occurred, I was able to also give a clear 'yes' to the question; has doing an activity stimulated me to feel experiences in relation to

light and colour? The data block was then coded with a blue square to represent a yes to this question too.

The term 'reminded me' also had been highlighted, and this represented the possibility that I had crossed subject domains. Reading the context in which this occurred I could ascertain that the term referred to the domain of art, whereas the activity was one of science. Therefore I was able to give a clear yes to the question; have I crossed the subject domains of Art, Science or Religion, through the process of thinking, feeling or willing? The data block was then coded with a green circle to represent a yes to this question.

By using the themes highlighted in the first constant comparison analysis, and reading these in relation to content I was able to deduce clear answers to the first five prior deduced constant comparison analysis questions. A red square was used to mark a yes to the third question, *has thinking about the subject inspired me to do the activity better?* And a purple square *for has having feelings about the subject inspired me to do the activity better?*

However there were some cases, where when reading through the text it was self-evident from the content that thinking was taking place, and yet no phrase was used to specifically indicate thinking. I decided to include these as a yes to the first question. There were other times when a theme had been highlighted, that did not specifically relate to the subject of light, dark and or colour. I decided in these cases not to mark these as a yes to the relative question.

I was therefore now able to access when a crossing of domains had taken place, and demonstrate that it had taken place due to the subjects of art, science and religion being focused around a common theme. Thus providing one answer to the second main research question;

- *How can this process enable a person to cross subject domains in their learning?*

3. The last three prior deducted questions, based on information given in the literature review, were designed to help answer the third main research question. But establishing a clear way to answer the last three questions was more complex. To answer these questions

first the block of data needed to have been already marked with a yes to the question; *have I crossed the subject domains of Art, Science and Religion, through the process of thinking, feeling or willing?* Then for the sixth prior deducted question, I needed to read the context to see if there was evidence of thinking about ethics, aesthetics or epistemology. This can be seen in the research log where blocks of information are marked with a yellow star (appendix C). For the seventh question I needed to look for evidence of a flow of feelings, a metamorphosis of sense impressions, or an indication of a sense of knowing through feeling, and this can be seen in the research log, where blocks of information are marked with a blue star (appendix C). And for the last question I needed to check for evidence to indicate that a new goal had been established which related to the seeking of truth, goodness or beauty, which is marked in the research log with a red star (appendix C).

Looking at the coding for these last three questions in the research log, it is evident that higher levels of knowing, be it through thinking, feeling or willing, were evident in this process. This gives a partial answer to the third main research question;

- *Does, and to what extent does crossing subject domains lead to higher levels of knowing?*

4. However further analysis was required to indicate the degree the latter were evident and whether this is stimulated by the crossing of domains. Once the descriptive sampling data was coded with yes answers to the questions given in the section above, I was able to use classical content analysis to count and record the occurrences of yes to those questions. I then turned that information into graphs, to clearly demonstrate the outcomes in relation to the different sets of activities. (These graphs can be viewed in appendix D at the back of this exegesis).

In graph A, (appendix D) it could be seen that regardless of which set was being assessed, doing an activity stimulated thinking more often than it stimulated feeling. However it is noticeable that feeling is also effected a substantial number of times across all sets. To a much lesser degree, thinking and feeling have inspired the will to do the activities better.

It would appear from this graph that thinking is easier to attain than feeling or willing, and that willing occurred the least. However I thought that it should be considered whether the method of writing down thoughts conducted in this research engendered the occurrence of thinking, rather than feeling or willing.

Furthermore it was only increased will that was noted on the graph, where upon the activities where will was being measured were in themselves already actions of will. Therefore this graph could not be used to measure an amount of thinking in relation to an amount of feeling and or willing. But thinking could only be measured against thinking. And likewise with the occurrences of feeling, and of willing. Thus in this regard I could only determine that the highest amounts of thinking occurred in sets 7, 9, 11, 12 and 13. The highest amounts of feeling occurred in sets 4, 6, 8, 13, 14, 15 and 16. And the highest amounts of increased will occurred in sets 3, 6, 7, 11 and 12 (appendix D).

The outcome that Graph A showed, *is that thinking has been stimulated by doing an activity, feelings were stimulated by doing an activity, and acts of willing were stimulated by feeling and thinking.* This research did not offer an accurate way of comparing the degree of thinking, with the degree of feeling or willing. But it did show in which sets each of these took place more often, and this can be examined against other occurrences in those particular sets.

5. In graph B, the yes answers to the last four questions that related to the crossing of domains, and occurrences of higher knowing, could be seen in relation to the sets. Crossing subject domains happened either through thinking, feeling or willing, a substantial number of times across all sets. These occurrences were all related to the topic of light, dark and colour. Therefore doing science activities, followed by art activities, followed by the reading of spiritual literature, all relating to a particular topic, did substantially effect the amount of times these domains were crossed in thinking, feeling or willing.

This graph also showed that higher levels of knowing could be achieved after crossing subject domains. This was achieved more often with heightened thinking, and deeper creative experiences, and to less of a degree, the setting of virtuous goals. Therefore *crossing subject domains did lead to higher levels of knowing.*

6. In graph C (appendix D) thinking and feeling occurrences in relation to light, dark and colour were compared with the occurrences of combined higher knowing and of the crossing of domains. There were 7 sets where thinking and feeling were above the mean average of their overall number - sets, 6, 7, 9, 13, 14, 15 and 16. Only 1 out of these 7 sets showed the crossing of domains to be lower than their mean average. Only 2 out of these 7 sets showed the occurrences of higher knowing was less than its mean average.

A pattern was found that did not occur in graph A (appendix D), as it did not appear to matter whether it was the higher number of occurrences of thinking or feeling that effected the crossing of domains and higher knowing, but rather their number combined. It could be seen, for example, that in set 9 thinking occurred more often than in any other set, while feeling was very low, while in sets 15 and 16, thinking and feeling were equal, yet all three sets added up to a high level of combined thinking and feeling.

Thus a pattern did become visible where upon increased occurrences of thinking, and or feeling, in relationship to the topic of light, dark and colour, whilst engaging the will in a related topic, corresponded with increased occurrences of the crossing of the subject domains of art, science and religion in relationship to that topic. This in turn corresponded with greater occurrences of higher knowing, not necessarily related to the same topic. This deepens understanding of the answer to the third main research question.

- *Increases of thinking, feeling or willing activity correspond to increases in crossing subject domains.*

Set 7 and Set 13 are the two out of 7 anomalies where this was not the case. Examining set 7, and looking back at graph A it is possible that energy was diverted from higher knowing to will action since the occurrence of thinking that inspired me to do the activity better, was particularly high. However this did not explain what occurred in set 13, which has remained an anomaly.

7. The data was regrouped into domains of art, science and religion. The yes answers given to the prior deducted questions provided for the Constant Comparison Analysis, were given a percentage against how many times they could have occurred. In the case of the art and

science activities there were 64 times when a yes answer could have been given. In the case of the literature there were 16 times when a yes answer could have been given. On this basis Graph D (appendix D) was constructed.

Looking at graph D (appendix D) it is noticeable that whether the activity was science, art or literature, all stimulate thinking to a fairly even degree. This contested the notion that the domain of science was more related to thinking than the domain of art, or religion. However it did still leave room for the notion that science, as a striving for truth through thinking, could be experienced in any domain.

Feeling was achieved substantially more often in the domain of art than in the domain of science. But that it did occur in science suggested that art as an experience of beauty through feeling, could be experienced in the domain of science. Of note here was that feeling was achieved even more often in the religious literature than in art. However literature is not a true representation of religion, and in this case it was considered that literature is an art form.

Of particular interest in Graph D was that the crossing of domains occurred substantially less often in the domain of science, than in the domain of art, and occurred most often in the domain of religion. However in regards to Religion this is not entirely clear, since literature as previously mentioned is also an art, and the data for religion was not gathered in the same way as that for art and science. The same pattern was also evident in the occurrence of higher thinking and higher feeling, which occurred less often in the domain of science than in the domain of art and religion.

This suggested that artistic and or religious activities were more necessary for higher knowing than science. If we take the definition of science as a search for truth through thinking, then Ethics, aesthetics and epistemology were an indicator of higher scientific thinking. These have been developed through thinking, and represent a search for truth at the highest level. Yet they occurred less often in the domain of science than in the other domains. On the other hand, the setting of new virtuous goals, which would normally be associated more with the domain of religion, occurred more often in the domain of science.

Consideration was taken when evaluating this analysis that the data was retrieved in two different ways, which lead to a margin of error in their comparison. The data on the art and science activities was taken using descriptive sampling; a comparison between these was reasonably reliable. But the data on the literature was taken from reflexive thinking after selecting a piece of literature that resonated with the activities. It was therefore logical to assume that in regards to the religious literature, there would be more occurrences of the crossing of domains, and more occurrences of higher knowing experiences due to the way in which the data was retrieved. Therefore while the data from the literature was useful for selecting work for the teachers' resource book, making a comparison between this and the domains of either science or art, could only give a rough indication, and was not reliable.

However even after considering the margin of error, it would still seem that Science, as a search for truth through thinking was more likely to be found in the domains of art and religion than the domain of science. And that religion as the striving for goodness through willing, was more likely to happen in the domains of science and art where a practical activity was taking place, than in the domain of religion, where a contemplative reading of text was the activity. Whereas art as an experience of beauty through feeling, could occur in any domain where feeling is experienced, and occurred least in the domain of science since that is where feeling experiences appear to have occurred least.

This would need further more specific research to explore fully, but it does open the question of why the subjects of art, science and religion have domains in which they were taught. It would seem that loosening these domains and merging the subjects would increase the possibility of developing higher knowing. Therefore an interesting area of further research could be; could teaching science be more effective in the domain of religion, and teaching religion be more effective in the domain of science?

8. The action research revealed a theme regarding the need to re order activities for better consistency between art, science and literature. This was an end result of the action research process that had not been fully addressed within its research cycle. However notes were taken to indicate which activities related well in the particular sets, and which related better



to activities in other sets. There were also indications of when this was more of a generic relation, and when it was more specific.

Based on this information a number from 1 to 6 was given to each set on the basis of how relevant the activities in the set were to each other. One point was allocated for each of the following occurrences:

1. *Generic connection of science to literature*
2. *Generic connection of literature to art*
3. *Generic connection of art to science*
4. *Specific connection of science to literature*
5. *Specific connection of literature to art*
6. *Specific connection of art to science*

For example, if all related to each other specifically, then the set was given 6. If all had a generic relationship but only art and literature related specifically, then the set was given a 4. That being that 3 was given for the generic connections of all, and an extra 1 was given for the specific relation between art and literature.

In most cases I could determine the information needed to rate a 1 to 6, from the action research data, and the reflexive thinking data on the literature. But in some cases, in order to be clear what was specific and what was generic, I read through the data on the science and art activities too. I recorded this information in a chart after the other data. Then I used this information in a graph E (appendix D), so as to weigh this information against increases in the crossing of domains, and occurrences of higher knowing.

A pattern could be picked out in Graph E (appendix D). In the two cases where the degree of similarity between the three domains was higher than the average, it could be seen that the amount of times domains were crossed was on or above its average, and cases of higher knowing were well above average. Looking at the 5 occasions where higher knowing was above its average it could be seen that in each of these sets the crossing of domains and the

degree of domain similarity was also average or above. However looking at the 6 occasions where crossing domains was higher than its average, it could be seen that average or higher levels of domain similarity happen 4 out of 6 times, and average or higher levels of knowing happen only 3 out of 6 times.

Therefore it seemed that higher occurrences of crossing domains did not necessitate that there would be higher levels of knowing, or a closer relationship between subject domains. However average or above occurrences of crossing domains was necessary for a closer relationship between domains, and higher levels of learning to take place. It would seem then that crossing subject domains did not lead to higher levels of knowing, yet was a necessary platform of stimulation, that higher levels of knowing could develop out from.

It would also seem that where there was greater similarity between the three domains, there was also the occurrence of higher knowing. This suggested that the important question in relation to this research was not how many times a domain was crossed, but how closely related the three subject domains were. It would seem that a close relationship between the domains was what would actually lead to higher levels of knowing. A still deeper answer to the third main research question than the one given in section 6 above would be:

*Crossing subject domains was a necessary platform from which higher levels of knowing could develop. The greater the similarity between the three domains, the greater the occurrence of higher knowing.*

#### **4.3.2 Discussion**

The main purpose of this section has been to answer the main research questions given at the beginning of the methodology chapter. The action research stage of this thesis began this process by providing data that showed one approach to answering the question of how a union of art, science and religion could be achieved. Lesson activities on painting and physics were combined with religious reading material and all under the umbrella of a common theme. Furthermore what was revealed through this research was that the separate activities could be matched more closely than simply by an overarching theme, and that

this might have a bearing on how this would relate to the crossing of domains, and the development of higher knowing.

However in part 1 of this chapter it was found that another approach to this question could be taken. Examples of thinking, feeling and willing were found right across all three domains of activity. If as indicated in the definitions given in the introduction to this thesis, science is related to thinking, art is related to feeling, and religion is related to willing, then artistic, scientific and religious activity can be found in each individual subject domain. Therefore each domain already has a union of art, science and religion, leading to the assumption that there is no reason to try and unite them because they are already combined. Yet what is presented here is a very generic connection, and the action research indicated that a closer more specific connection between the three domains might lead to more crossing of domains and more occurrences of higher knowing. So in order to answer the second main research question – how can this process enable a person to cross subject domains in their learning? – I needed to first establish if crossing domains happened, and if having a closer connection between the subjects effected this.

Part 2 of this chapter established that domains had been crossed in relation to the common theme of light, dark and colour providing one answer to the second main research question. It showed me that in this case the crossing of domains happened in relation to the common theme, but this did not tell me if having a closer connection between subjects effected this further. However part 6 showed that crossing subject domains increased in correspondence with increased thinking, feeling and willing activity. And part 4 showed that thinking, and feeling were stimulated from doing activities, therefore using will. And will was stimulated by thinking and feeling.

Therefore in answer to the second main research question, incorporating thinking, feeling and willing activities in the same domain regardless of subject or combined theme, stimulated greater occurrences of thinking, feeling and willing, and the more thinking feeling and willing that takes place, the greater the amount of crossing domains. The crossing of domains happens when there is a common theme, but it is not known if this increases when the shared subject is more specific.

The third main research question to consider regards the relationship between crossing domains, and higher knowing. Part 3 of this research review showed that higher learning was able to take place, but not whether this was related to crossing domains. Part 5 showed that crossing subject domains did appear to lead to higher levels of knowing. But part 8 clarified this by showing that crossing domains didn't cause higher levels of learning to take place, rather it showed that crossing domains was a necessary platform from which higher levels of knowing could develop.

To sum this all up, the unification of thinking, feeling and willing together in any subject or domain leads to increases in occurrences of thinking, feeling and willing, which in turn leads to greater occurrences of crossing domains. The more crossing of domains the greater the opportunity for higher knowing to develop. Then another outcome of part 8 takes this back to the question concerning more specific connections between the themes, by assessing that the greater the similarity between the three domains, the greater the occurrence of higher knowing.

What was surprising in this research was the extent to which thinking, feeling and willing manifested from the data, and played a part in the research analysis. This triad relates directly to the definition of art, science and religion given in the introduction chapter, and leads to a generic view of these terms. While the domains of art, science and religion that I have worked with in this research are more specific, and the areas of painting, physics and religious literature are more specific again. The linking of these to a common theme focuses them into a still narrower selection, and linking more specific details between the three subject areas, narrows the selection down further. This narrowing and focusing by linking to a specific theme is shown by the research to lead to higher levels of knowing, and yet the triad in its generic form of thinking, feeling and willing, are what start the whole process rolling.

Another aspect of this research that was surprising was analysed in part 7, resulting in the question – could teaching science be more effective if taught in the domain of religion, and could teaching religion be more effective if taught in the domain of science? Here higher levels of knowing that relate to science are shown to occur more often in the domain of

religion, and vice versa. Since the way I gathered data on science was different from the way I gathered data on religion, this particular research is unreliable, however it would be an interesting area to study further.

Another important aspect of this section of research, is that it validates the need for a teachers' resource book that combines the domains of art, science and religion in the manner I have prepared material for. Were this need not to have been validated I would have structured the book differently, but since part 8 stresses the need for greater connection between the subject domains, this is what I worked with in the composition of the book.

## 5. DESIGN AND CREATION OF THE TEACHERS' RESOURCE BOOK

### 5.1 Process

The artefact of this thesis is a teachers' resource book which emerged out of the research process described in this exegesis. It takes the form of a series of lesson plans, showing the final outcome of a Waldorf teacher's planning. However it has been presented in an open way, so that it is less of a set of rigid lesson plans, and more of a teachers' resource open to adaptation, which can be utilised in different ways so as to suit individual teacher's needs.

The title is 'Light and Colour', with a subheading 'from the Perspective of Art, Science and Spirituality'. I chose this theme due to the links I envisaged being able to find in art, light physics and literature, thus linking art, science and religion. The title reflects the research presented in this exegesis, however where I have used the word 'religion' to stay in keeping with Steiner's terminology, I have in the resource book replaced this term with the word 'spirituality'. The definition I have presented for the former, as explained in the introduction, is I believe more easily recognised in contemporary times as the word 'spirituality'. Since the teachers' resource book may be read without the reader first digesting the exegesis, I decided to change the name to one where the meaning intended is more easily recognisable.

The book focuses on the time period from the mid seventeenth to the mid nineteenth centuries, which connects with what is taught in the Waldorf curriculum in classes nine and ten in regards to this subject (Lindenberg, 2004). However the open approach to the book allows teachers to adapt it to suit various models. The book can be viewed as a separate artefact presented with this exegesis, and may become published at a future date.

#### *Composition of the teachers' resource book*

Information for the book was gathered from the research described and analysed in the previous two chapters of this exegesis. As explained in the methodology, the content focus

for this book was narrowed down from a much larger area of interest. It includes science experiments by Newton from his book ‘Opticks’ (Newton, 1730/2010), and Goethe from his book ‘Theory of Colours’ (Goethe, 1810/1970). Using my own expertise in the area of art, I selected artworks that demonstrated particular usage of light, dark and colour, which relate to established artistic ideas from the timeframe of the mid seventeenth to the mid nineteenth centuries. These have been included in appendix B of this exegesis. I also looked at online texts from famous theologians, ethical philosophers, poets and writers from the same timeframe. This has also been included in appendix A of this exegesis, and further details of how these were selected, and how they were used as an activity have been described in the methodology.

The action research showed that some of the science experiments were too repetitive or unreliable for teaching students of class nine and ten age. Therefore I chose a smaller number to include in the teachers’ resource book. Throughout the action research process I made adjustments to the way I performed the more repetitive science activities, perfecting difficult parts of the process through trial and error. For example I found numerous issues setting up Newton’s experiments in which he used a hole in a black screen to let in sunlight. Ability to darken the room, changes of the weather, movement of the sun and size of the room and equipment proved too unreliable for classroom teaching. However through the trial and error process I found that I could use a strong torch inside a box with a hole cut in it, and by using this I had more control, and could make the experiments work more reliably. Once the setup had been mastered it was not a factor for not using the experiment. Therefore when choosing which experiments to use for the resource book, I chose those which showed a distinct transition from a previous experiment, that didn’t feel like it was too much of the same thing, and that felt progressively exciting. Since the reoccurring theme in the action research had been based on feeling frustration at the repetition, I countered this and selected the experiments based not only on a logical progression of scientific exploration, but also on the basis of how exciting they felt.

The art activities ran smoothly, partly due to my previous experience in selecting artworks to study for this age, and my experience in setting up lessons of this kind. I am well familiar with the developments made in the understanding and use of dark, light and colour by artists throughout this time period. I am also well aware of the difficulties of teaching students painting techniques without a prior build-up of skills. Therefore I began with a pencil sketch, a medium that I have found most students are very comfortable with, and slowly worked through a variety of mediums until finishing with a detailed watercolour. The Turner example I have used involves layer upon layer of transparent colour where upon constant consideration needs to be made to create the right hue and tonal depth in the finished piece.

This final activity involves multiple levels of artistic skill working in unison together. To do this the students need to be able to see spacial shapes and tonal value that can be developed in pencil drawing from the first exercise. They need to understand both complimentary and tonal colour balance, which is developed in the second exercise. They need to understand how reflection works, which is taught in the third exercise, and the difference between hard and soft lighting, which is experienced in the contrast between the third and fourth exercises. Throughout these activities the students proceed from using pencil, to oil pastel to chalk pastel, and gradually learn how to blend colour until they start mixing and painting with acrylics in the fourth and fifth exercises. Here they learn more intensively about colour depth, contrast, reflection, refraction and transparency, whilst developing skills in how to use brush strokes. Then as described above, in Turners painting they learn to use all these skills in unison.

This approach shows a steady progression that I worked on during the research. However there was a concern that manifested in the action research that I was pitching the work for the more advanced students in the class. Considering how this could be overcome, I decided that rather than providing completely different activities for students with less developed capabilities that the same effect could be achieved working on smaller sections of the activities. I observed the activities I was doing with that in mind, and took notice of



where smaller simpler areas of the pictures could be used to provide the same overarching experiences, techniques and knowledge desired for each art activity. For example I found that working with an enlarged area of the detailed helmet in Rembrandt's picture, that the students would experience and develop the necessary skills and understanding to move on to the next phase.

After meditating on this concern using the meditative questioning approach I describe in the methodology, I reached the further conclusion that not all students needed to develop the practical skills I had laid out a path for. Students who wanted to develop their practical skills, and perhaps pursue the arts to a more refined level, benefited from this approach, but this was not, nor did it need to be the goal of all my students. Using a reflexive approach to this contemplation I recalled that I have found in my own teaching experience that for some students whose natural tendencies lay in other areas, producing artwork at such a refined level can be experienced as painful. My meditation revealed that what is of benefit to these students is a more simple progression of aesthetic experiences. Deciding that it was suitable to leave out some of the more advanced skill building exercises for these students, I concluded that a simple watercolour exercise could replace the second, the fourth, fifth and sixth activities. This would involve painting the whole picture, but without detail, just looking at the colour hues, value, placement, balance and reflection, and not worrying about detail, accuracy of shape, or use of brush strokes. Exercises such as these are recommended in the Waldorf curriculum, but my experience had shown me that more talented students experienced frustration with them, for they wanted to create skilful watercolours, and hadn't yet developed the ability. I realised that the developmental approach I had created aimed at guiding very able students through a series of skill developing exercises to a stage where they could experience the subtle aesthetic nuances of a layered watercolour without frustration, because through this process they would have acquired a satisfying standard of ability. However other students, with less need for perfection in this area, could achieve the same overarching experience, without having to develop the same degree of practical skill.

Considering how I would include these options in the book, I decided that to include annotated pictorial descriptions of each option would become too complicated to follow. I decided that the more complex option needed detailed descriptions of the process, and that other options could be easily adapted from those. However I decided that suggestions could be made in the text indicating which areas of the work could be focused on for different levels of ability, and where a simple colour exercise could be used instead of the detailed process described.

With the art and science activities selected as mentioned above, I matched the chosen extracts of literature to them as part of the action research process. However in some cases literature related to art and not science, or vice versa. I noted where this took place, and this needed to be considered in the next stage of the process.

The intention of the teachers' resource book is to show a way of working in an interdisciplinary way with art, science and religion. A background of theories for why this was of value was given in the literature review. Having gathered an area of material to research for the teachers' resource book, I next needed to find out how such an interdisciplinary way of working could be done. Yet at the same time, I wanted to validate the importance of the book by establishing if and how this approach could lead to higher levels of learning, as suggested in the literature review. This process has been described in the preceding two chapters.

While there was a general theme to follow in the research, the specific art and science activities were not matched with each other in any particular way, they each followed their own order. The art was done chronologically, and the science followed the order laid out in first Newton's, and then Goethe's books. Only the religious texts were chosen to specifically match the activities as part of the research process. As described in the action research chapter a repeating theme showed that this might not be the best approach in which to connect these subjects. This was further validated in the last chapter where it was established that the greater the similarity between the three domains, the greater the occurrence of higher knowing.

Despite the freedom to move and adjust the activities as part of the action research process, I was unable to reorder them to better match without first experiencing them. I could make some adjustments on the basis of predictive guesswork, but redoing each combination of activities to test how compatible they were would have involved a much longer research process. However a more straight forward approach I could take was to include comments in the active research that showed how well the activities related to each other, and note down if an activity related more smoothly with one previously done. The criteria for measuring this smoothness was not strictly formed, rather it left me free to note natural connections. One example was where the reflective principles in the science experiments linked naturally with the painting of reflections in a particular painting, and the poetic descriptions of a reflective light in the literature. More specifically, that is the link between the activity on reflection in Rembrandt's 'Man with a golden helmet', with Goethe's experiments on reflection, and Fenelon's writing on the reflective moon.

To a large extent the realigning of the activities could be done by reading through the action research comments that show how well the activities relate to each other, and if an activity relates better to one previously done. But where there was no comment relating one activity to another, or not enough information, links could be made by reading through the other information logged in the research process. Making logical connections was quite a straightforward process, but I noticed it was particularly important to give attention to where feelings and willing intentions were described. The definitions given in the literature review indicated that these were more important to the areas of art and religion, where as a focus only on logical connections would give preference to a scientific process in the forming of connections. This decision was validated by the research analysis where it was found that it was not just an increase in thinking that led to a crossing of domains but, an increase in thinking and feeling whilst doing an activity. This in turn corresponded with greater occurrences of higher knowing.

From a practical perspective I cut up a copy of the activity log along with its analysed coding and rearranged activities to suit what had been indicated in the action research

entries. Then I read through the descriptive sampling, and literature entries looking for links and used reflexive meditation as described in the methodology to aid the process of rearranging activities. The process became similar to doing a jigsaw puzzle, with some pieces able to fit into several areas, and others not seeming to clearly fit anywhere. I needed to consider whether to include all the activities I had selected as suitable for the class. I decided that it was not appropriate to leave some out simply because they did not fit specifically with other activities, particularly if they were part of a scientific or artistic process. In these cases I would just need to rely on the general connection of light, dark and colour, to aid students ability to cross domains and develop higher levels of knowing.

The next question that presented itself was to how to order the book. My original intention had been to lay the book out chronologically in keeping with the idea of a historical evolution of consciousness. If the book were to be laid out according to the chronology of the spiritual literature the art and science lessons would lose all order of process. The literature did not need to follow such an order to be effective, but science activities did need to follow an order of process, however in most cases a group of experiments were quite separate and distinct from another. Goethe's experiments often built upon, or were a reaction to Newton's, so for the resource book I made the decision to group the science content into topics that better reflected this process. The only ordering I found necessary for the science sections was to keep the activities in related groups, but these intact groups could be moved around freely. The art activities on the other hand, required a firm ordering process. Since the creation of these had been part of the action research process, and I had a great deal of prior experience in the design of such lessons, I had quite naturally created these in such a way that they gradually increased skill level, and deepened awareness of light, darkness and colour. I had selected right from the start paintings that both followed a chronological order, and progressed in subject depth of knowledge, whilst building up a progression in the mastering of techniques. As a result of this analysis, I decided to order the art activities in chronological order, interspersing these activities with groups of science activities and passages of spiritual literature, whilst ensuring that there was a relationship between all three.

### *Text for the teachers' resource book*

On that account material was selected for use in the teachers' resource book, and the book was given an order of process. I then began to write out the text for the book basing the scientific work on Newton and Goethe's own writings, along with my own practical contributions from having done the experiments. The literature I quoted directly from its respective authors. I wrote the text for the artistic activities based on my own art teaching experience and the practical observations I made while undertaking the research. I had taken and coded photos throughout the research process and I placed these between the blocks of text they related to. With all the information placed in the book I could now address the design and layout of it.

### *Design of teachers' resource book*

Taking what I described in the methodology as a reflexive meditative approach to the overall construction of the book, I could see that the book flowed from one activity to another, but this was too uncomfortable for readers to take in one large chunk. It needed to be divided into groups, and yet it was one continuous theme. I began by setting up a layout template for the groups of science activities. I then set up a layout template for the art activities using the same structure, but using a different colour for the design features. The literature was not an activity, but rather a contemplation, so I decided to treat this differently setting it in a neutral grey panel using a more thought provoking font and layout. In this way the art and science sections could be easily recognised throughout the book, and the literature panels provided a welcome break from the activities both in context and visually. Still considering the overall construction I decided that while chapters would be too numerous for all the various groups of activities, I could break the book up where each new painting started. Something new and different was needed to break these sections up, so I decided to write an introduction to each painting, placing it in the stream of time, history and artistic development, and describe the changes in light, dark and colour in each section. I was able to do this based on my own authority as an artist and art teacher, and backed the work up with quotes from other art historians I am already familiar with.

As an experienced graphic designer I had the skills to design illustrate and layout the book. I took particular care choosing the fonts and colours repeated throughout the book. With such a large body of text it was important that the text used was easily readable and yet it needed to evoke the right feeling for the content of the book. The text needed to be carefully laid out and matched with the headings, and a design needed to be created where upon readers could take in the relevant headings and subheadings at a glance. Careful attention was made in selecting an elegant, thought provoking, and yet contrasting font for the literature sections.

Particular attention was also paid to the selection of pastel colours gently contrasted with the grey panels in the activities pages. These pages were so densely packed that a strong use of colour would have easily overpowered the page, making it uninviting to read. However an entire book of pastel coloured pages would give a less serious more insipid feel to the book than that desired. Therefore I decided to contrast these densely packed pastel and white pages with a simple elegant black page at the beginning of each section. I have taken particular care here to create a simple elegant design suitable for a serious artistic context. These in effect not only provide visual relief from the pastel pages, but also break the book up into digestible sections and create a more sophisticated mood for the whole book.

The photographs taken by myself in the research process needed to be selected and colour adjusted before being used in the layout. The quality of these pictures was such that I could not adjust the paper colour to white and still retain the correct colours of the drawings, so a compromise was reached, and the paper colour used was a consistent pale grey. The only visual content that had not been created by myself were the images of the famed original paintings on which the art activities were based. I am aware that if this book were to be published outside of the university, I will need permission to use these images, for while the artists died over a hundred years ago, it is still usual to gain permission of the gallery that owns them.

The cover image is a photo-shopped adaption of one of the photos taken in the research. My intention was to show light, dark and colour in a simplified elegant way that matched

the style of the black introduction pages on the inside. A simple spectrum line runs beneath the heading, and continues on each black page subtly echoing the image of a spectrum in a dark room. And a slight band of yellow and blue around the title font echoes Goethe's experiments where black and white edges viewed through a prism are seen with coloured bands.

## 6. DISCUSSION

The teachers' resource book is the final outcome of this research, and is designed to be an example of a different more holistic approach to teaching than the traditional departmentalised approach. One of the drawbacks to creating lesson plans using this approach is the high degree of planning and preparation required. As described in the design process section, a person really needs to have experienced the different activities in order to access how well they connect across domains. This is particularly the case when the connections are not only made on the basis of thinking, or the making of logical connections, but as shown in the chapter assessing the main research questions, these connections can also be made on the basis of feeling and will.

Also as described in an earlier chapter, I was faced with an obstacle – do I follow chronological order, order of process or simply create a random order ensuring similarity of connections? As described I was able to maintain the integrity of all three subjects by following chronological and process order with art, order of processes with science, and religious literature was simply placed where connections were made. But it took a very creative/lateral thinking approach to solve this, and I expect this will not always be easily solved when cross linking subjects like this. However the results from the chapter addressing the main research question indicate that lesson approaches like this are worth the effort of creating them.

Another aspect to consider is whether a teacher would be able or allowed to work in this integrated way. A teacher would need to have the autonomy in their classroom to work across the curricula. As a teacher working at a small independent Waldorf school I have this autonomy, but I am well aware that doing this would be a difficulty where more rigid structures are in place. It is for this reason that I challenge the need for rigid separations of subjects.

The evidence from my research showed that if science is viewed as a striving for truth through thinking, then this could happen in all subjects. If art was viewed as the experience of beauty through feeling, then this could also happen in any subject. And religion could also happen in any subject if it was viewed as the striving for good through willing. In this



respect art, science and religion could be integrated in a generic way in any subject, which could lead to crossing subject domains through either thinking, feeling or willing, and could lead to higher levels of knowing.

However the research also showed that there was a far greater chance of crossing those subject domains and gaining higher levels of knowing if there was a more specific link than the general theme of light, darkness and colour, and if the domain crossing was more specific. That is what the teachers' resource book does in relation to the subject of painting, light physics and religious literature on the subject. But to teach this way in practicality would require either a very close relationship between three specialist teachers, or flexibility on the part of a teacher to bring in, at least a taster, of other specialty subjects into their lessons. This would require a breaking down of the separation of subjects, and/or the loosening of teacher requirements for specific subjects.

As shown in the literature review, such an idea has not gone undiscovered. Poststructuralists argue against the era of structuralism, manifesting in what Hargreaves (1994) described as "a thickly woven mat of materialised reform" (p. 58). Hargreaves goes on to explain that this mat has been intermittently laid by both sides, replacing older educational views on community and religion. And he pointed out that while educational theorists had an idea of what an effective school should be, they had no idea of how to create one. Meanwhile Foucault called for an analysis of such accumulations of reform, structural and post structural, breaking down societies out-dated constructs, and pulling them apart, so that new conscious constructs could be formed in keeping with society's present needs (Foucault, 1969; Deacon, 2006).

So what new constructs could I see emanating out of this research for a more integrated learning approach? Within the structure of timetabled lessons I could see myself able to conduct a series of art lessons, bringing in a short science demonstration, and reading some related literature while the students work on their artwork. The teachers' resource book that has come out of this research has been designed so that a science teacher could do the same putting more focus on the science, perhaps only showing or describing the artworks.

A philosophy, theology or English teacher could put more focus on the text, showing or referring to the science or the art. The resource book shows activities together in new constructs, so that art religion and science come together under the theme of new constructs such as reflection, refraction, complementary colours etc.

This poses a problem for specialist teachers who if new constructs like this are to be approached, require them to learn other disciplines. In an environment where there is a range of specialist teachers, a teacher could get advice from others on short activities that are not in their usual area of teaching. As a Waldorf teacher I see this as a positive thing, a well-rounded understanding is advised for Waldorf teachers, as well as continual interest in learning. However I can see this could be an issue in some areas. There are subject areas that require more skill or experience when teaching them to a class. Certain chemistry experiments could be dangerous if done by an inexperienced teacher for example, and it would take more than a quick explanation to learn a skill like juggling. Therefore this approach to a new teaching structure would require some guidelines.

These new constructs could be also applied in other lesson environments. One example I would be particularly interested in would be an open classroom situation, where there were perhaps three specialist teachers with rotating groups of students. If a good balance between clear instruction and freedom to explore were created, I could see this being an ideal learning environment. Students could for example partake in three activities on reflection, in each of the science, art and religion areas, and then be given the opportunity to take one activity further. Some might work up paintings of Rembrandt's man with a golden helmet, others might write poetry on the spiritual quality of the moon, while others might record and measure the reflective properties of different objects. In this way there could be a blend of an overarching experience of all subject areas, balanced with the opportunity to choose an area to delve more deeply into.

Like Wilber I don't see the answer to an integrated approach being a complete fusion of art, science and religion (Filipsone, 2009). But rather I see the need for separate subject areas, which could be tightened up for formal instructions, and loosened off for new

integrated constructs. The teaching structures themselves would need to expand and contract with a kind of breathing, between separate recognised domains with their own disciplines, and a letting go of all these, expanding into other domains and sharing a common contextual theme.

## 7. CONCLUSION

### 7.1 Art, science and religion, and higher knowing

The terms art, science and religion that have been used throughout this exegesis have entered on their own process of development throughout the research. As described in the introduction, these terms were used due to their connection with Steiner's pedagogical approach, and it was recognised that his use of the words differed from the associations given to them today. Defining these according to Steiner also proved difficult, as they were used in various contexts throughout his many works. A simplified definition was created linking these to thinking, feeling and willing, and truth, beauty and goodness. These definitions proved to be generic and overarching.

Throughout the literature review more tightly defined terms began to emerge out of art, science and religion, specifying aspects of these, such as creativity, intelligence and wisdom. Furthermore in building the research structure it was found that particular areas of focus within each of the broad areas of art, science and religion needed to be specified in order to contain the research. Physics, painting and quotes from spiritual literature on light, dark and colour were chosen. The need to incorporate both an overarching generic, and a specific focus caused a number of difficulties in this research.

For example art in a generic sense was linked to beauty and feeling, but in the specific area of painting that I used in this research, thinking and willing were also engaged in the painting, while not necessarily being a component of art. Some contemporary examinations of these problems defined the thinking done in an art domain as creativity, but others related creativity to feeling and/or willing. There seemed to be no consensus on categorisations of components of art, science or religion, for a component of one domain could be utilised in others.

The research showed that thinking, feeling and willing appeared in each domain area that I had selected, and by the generic definitions given in the literature review, this meant that

art, science and religion took place in each of the specific areas of art, science and religion. That could then have been interpreted to mean that there was no need to unify art, science and religion, because they were already unified. However the literature review revealed that there were many who perceived them as separated and in need of unification.

Further research revealed that linking the specific areas of art, science and religion more specifically to particular topics increased the number of times the domains were crossed in any of the inner activities of thinking, feeling and willing. It showed that while this did not necessitate an increase in occurrences of higher knowing, it did form a necessary platform on which greater occurrences of higher learning could, and in many cases did, take place.

It would therefore seem that it was not art, science and religion in their generic forms that need unification, but art, science and religion in their specific forms, if higher levels of knowing were to be achieved more frequently. And the more closely connected the topic was between them, the more times domains were crossed, and in most cases the greater the occurrences of higher knowing.

The terms art, science and religion seemed to acquire their own new definitions as the research in this thesis evolved. Art became the action of creativity as the felt outcome of aesthetic experience. Science became a search for truth through intelligent practice as well as philosophical thinking. And Religion became spirituality followed by wisdom that leads one to positive action.

## **7.2 Thinking, feeling and willing**

As mentioned in the literature review, and above, thinking, feeling and willing were closely linked to the generic definitions of art, science and religion. They were also reoccurring themes that emerged out of the descriptive sampling data, which in turn lead to their use when constructing prior deducted questions for the analysis. It was found that doing activities, in itself a will activity, increased occurrences of thinking and feeling across all three domains, and the more a person thought or felt, the more they crossed subject domains, and the more they experience higher knowing.

It appeared that science as a search for truth through thinking occurred more in the contemplation of religious literature and art activities than in the science activity as expected. And it appeared that religion as the striving for goodness through willing occurred more often in the science activities. This gave credence to the idea of a more open approach to teaching and a breaking down of rigid domains in order to meet learning expectations. However it needs further research.

Since this research did not set out to measure thinking, feeling and willing, it was not set up to measure these against each other. The descriptive sampling method that was used was likely to have recorded thinking, more easily than feeling or willing, so a different form of research would need to be devised to compare which occurs more often in any outer activity, and to clarify if any one outer activity induces thought, feeling or will more often than another.

### **7.3 Teachers' resource book**

The action research revealed ways in which art, science and religion could be unified, but it also revealed ways in which it could be more effective. The artworks were quite complex, and options needed to be provided to allow for less able students. A meditative process was combined with the action research cycle to determine how this could be done, and notes were included in the written text in the book to cover this. The setup of the science experiments also needed simplification, and this was done as part of the action research cycle. The action research also provided data to help the selection process for what was included in the book, and indicated that a new ordering would be needed. These ideas were further developed using information from the descriptive sampling data, and meditative practices.

The original intention was to put everything in the book in a chronological order, with the assumption that an evolution of consciousness, as described in the literature review, would show in an artist around the same time as it would in a scientist or theologian. However what manifested through the research was that while ideas across the three domains were loosely connected through the subject of light, dark and colour, realigning the activities

could make better more precise connections. The research showed that doing this improved the occurrences of crossing domains and higher knowing. This also demonstrated that the evolution of consciousness should not be seen as one linear progression, but that ideas can bounce around between individuals and domains in pockets of time.

Layout of the book posed a problem, as there were lots of bodies of information and no chapters, which made it hard to read. With no chapters, a different way of breaking the book up needed to be found. As explained in the design and creation chapter, a decision was made to order the book around the art process. This led to a decision to write an introduction to each new artwork and include these as design features that break the book into readable sections. The result was a design that has strong black pages separating blocks of pastel coloured information, in which each domain area is easily recognised throughout the book, and yet intertwined around more specific topics.

The resulting book demonstrated a new structuring order different from the chapter approach normally expected. In this way it reflected the restructuring of domain classifications normally expected in school systems. And yet the book still had breaks that allowed for a sense of breathing when reading it. The restructured approach to teaching suggested in this research still allowed for focus around particular topics, and breathing between them. Furthermore each body of information is recognisable as being either from the domain of science, art or religion, even though the bodies of information intertwined and connected according to subject, which reflected the need to preserve the disciplines of the different domains in teaching, whilst unifying them.

The teachers' resource book forms the end result of this research process. It demonstrates one approach to how the subject domains of art, science and religion could be intertwined whilst retaining the integrity of each area. All the work is anchored to the topic of light, dark and colour within a time frame. This book demonstrates a way in which other books, or lesson plans could be worked around a topic rather than restricted to a domain area. It could be used as a guideline for other teachers, or directly as a set of lesson plans.

## **7.4 Scope of this research**

While this research has addressed particular questions in regards to the unification of art, science and religion, it has at the same time battled with hidden overarching questions. It was found to be necessary to reduce the generic meanings of art, science and religion, into selective metasubjects, in order to legitimise the research as logical. A logical process was used to simplify the research, and yet to maintain a holistic approach it was necessary to also involve intuitive thinking. It was found that only through an intuitive process, could a generic concept of the whole be maintained. The interspersing of meditational approaches with established social research methods throughout the research gathering and analysis stages of the research has provided a demonstration of how focused, holistic research can be conducted. This methodological approach could be beneficial to social researchers looking for a way to marry logic and intuition, or the generic and specific in their research.

Both the meditative, and the auto-ethnology approaches used in this research allowed for a deep inward looking process enabling subtle connections between topics to be identified for use in the teachers' resource book. They also provided data on which to measure subtle changes in scientific thinking, artistic feeling and religious or wise willing. However the resulting teachers' resource book could be used as a basis on which to widen the research, and measure how this works across a large number of students.

The teacher's resource book could be used as a model for other approaches to the unification between art, science and religion, focusing on other metasubjects, for example, a relationship between music, biology and religious customs. This book could also be used as a basic framework on which to try new holistic approaches to teaching structures, such as integrating other subject domains into a lesson, or an open classroom approach as suggested in the discussion section of the design and creation chapter.



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## Appendix A:

### Theologians, ethical philosophers, poets and writers whose works are used in this research

Lifespan 1608 – 1674

Milton, J. (1667). *Paradise Lost*. Retrieved October, 2014 from [John\_Milton]\_John\_Milton\_Paradise\_Lost(BookZZ.org).pdf

Lifespan 1632 – 1677

Spinoza, B. (1677). *Benedictus: Ethics*. Retrieved October, 2014 from <http://www.gutenberg.org/files/3800/3800-h/3800-h.htm>

Lifespan 1651 – 1715

Fenelon, F. (1695-1715. approx.). *Spiritual Progress*. Retrieved October, 2014 from <http://bookzz.org/book/1334761/32ee30>

Lifespan 1651 – 1715

Fenelon, F. (1713). *The existence of God*. Retrieved October, 2014 from <http://www.gutenberg.org/files/11044/11044-h/11044-h.htm>

Lifespan 1667 – 1745

Swift, J. (1726). *Gulliver's Travels*. Retrieved October, 2014 from <http://www.gutenberg.org/files/17157/17157-h/17157-h.htm>

Lifespan 1759 – 1805

Schiller, F. (1786). *Philosophical Letters on Religion*. Retrieved October, 2014 from <http://www.gutenberg.org/files/6799/6799-h/6799-h.htm>

The Brothers Grimm. (1812). *Fairy Tales*. Retrieved October, 2014 from <http://www.gutenberg.org/files/2591/2591-h/2591-h.htm>

Lifespan 1749 – 1832

Goethe, J. (1832). *Faust*. Retrieved October, 2014 from <http://www.gutenberg.org/files/14591/14591-h/14591-h.htm>

Lifespan 1768 – 1834

Schleiermacher, F. (1836). *Introductions to the dialogues of Plato*. Retrieved October, 2014 from file:///Users/joe/Downloads/[Friedrich\_Schleiermacher]\_Schleiermacher's\_Introd(BookZZ.org).pd

Lifespan 1780 – 1844

Abercrombie, J. (1839). *The Philosophy of Moral Feelings*. Retrieved October, 2014 from <http://www.gutenberg.org/files/22364/22364-h/22364-h.htm>

Lifespan 1797 – 1878

Hodge, C. (1878). *Justification*. Retrieved October, 2014 from <http://www.ntslibrary.com/PDF%20Books/Justification-CHodge.pdf>

Lifespan 1844 – 1900

Nietzsche, F. (1886). *Beyond Good and Evil*. Retrieved October, 2014 from <http://www.gutenberg.org/files/4363/4363-h/4363-h.htm>

## Appendix B:

### Artists and artworks used in this research

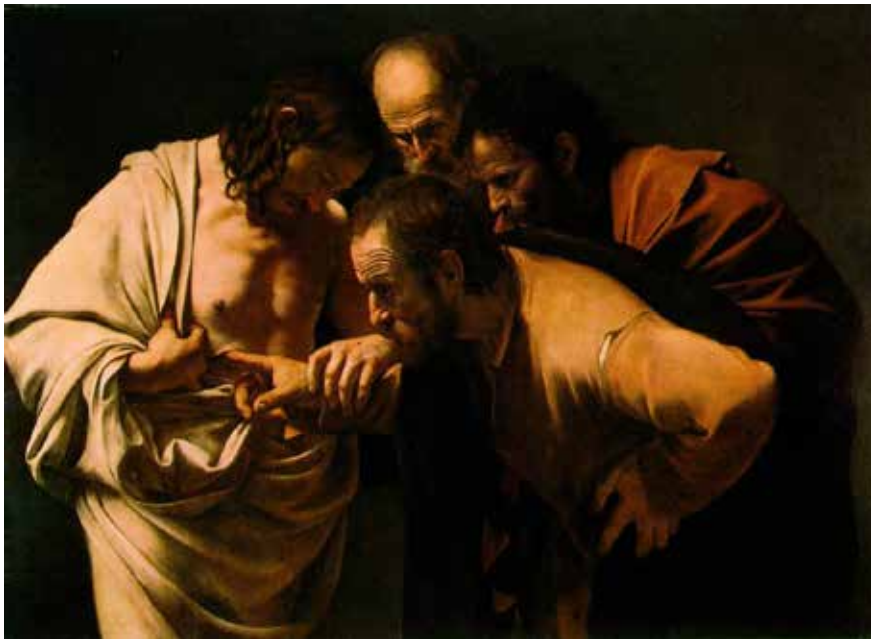
#### *Michelangelo Merisi da Caravaggio*

The Incredulity of St. Thomas 1601/2

107 x 146 cm

Oil on canvas

Sanssouci, Potsdam



Picture retrieved October 2014 from <http://all-that-is-interesting.com/seventeenth-century-art-most-significant-artists-of-the-baroque-period>

#### *Light and Colour theme:*

Hard dramatic lighting, colour is only a part of Chiaroscuro effect. Light is used to draw focus to a particular area in the painting.

**Nicolas Poussin** (French Baroque artist)

Diana and Endymion. c.1630.

Oil on canvas.

The Detroit Institute of Arts, Detroit, USA.



Picture retrieved October 2014 from <http://www.abcgallery.com/P/poussin/poussin18.html>

*Light and Colour theme:*

Soft flooding of light over the background, Strong darks in the foreground pulling a curtain over the bright classical scene. Introduction of colour contrast between gold and blue.

**Rembrandt** (Dutch Baroque artist)

The Man with the Golden Helmet circa 1650

67.5 x 50.7 cm

Oil on canvas

Gemaldegalerie, Berlin



Picture retrieved October 2014 from [http://commons.wikimedia.org/wiki/File:The\\_Man\\_with\\_the\\_Golden\\_Helmet\\_\(Rembrandt\).jpg](http://commons.wikimedia.org/wiki/File:The_Man_with_the_Golden_Helmet_(Rembrandt).jpg)

*Light and Colour theme:*

Hard dramatic lighting, colour is only a part of Chiaroscuro effect. Particular focus is put on how light reflects off ornate shiny and matt surfaces.

**Diego Velazquez** (Spanish Baroque artist)

Las Meninas (The Maids of Honour) 1656

Oil on canvas

318 x 278 cm

Museo del Prado Madrid



Picture from

Krausse, A. (2005). *The Art of Painting; from the Renaissance to the present*. Germany.  
Konemann

*Light and Colour theme:*

Hard dramatic lighting, colour is only a part of Chiaroscuro effect. Use of light in composition has become much more complex. Brightest light enters through at the back of picture lending mystery to what lays beyond. Pictures are now inside pictures, and reflection in mirror has become part of the composition, and part of the mystery behind the paintings meaning.

**Jan Vermeer** (Dutch Baroque artist)

The Art of Painting 1665

Oil on canvas

120 x 120 cm

Kunsthistorisches Museum, Vienna



Picture from

Krause, A. (2005). *The Art of Painting; from the Renaissance to the present*. Germany.  
Konemann

*Light and Colour theme:* Hard dramatic lighting, colour is still only a part of Chiaroscuro effect. Use of light in composition has become much more complex. Brightest light enters through at the back of picture lending mystery to what lays beyond. Pictures are now inside pictures. Shadows are studied in detail and become part of the composition.



***Jean-Honore Fragonard*** (Rococo artist)

The Swing 1767

Oil on canvas

81 x 65 cm

Wallace Collection London



Picture from

Krause, A. (2005). *The Art of Painting; from the Renaissance to the present*. Germany. Konemann

*Light and Colour theme:*

This meets up again with Poussin's theme, light atmospheric soft light in the background with strong dramatic light in the foreground, details soft in background and sharp in the high contrast light. Background colours contrast with orange dress.

***Joseph Wright*** (English Enlightenment artist)



Experiment with an Air Pump 1768

Oil on canvas

183 x 244 cm

National Gallery, London



Picture from

Krausse, A. (2005). *The Art of Painting; from the Renaissance to the present*. Germany.  
Konemann

Light and Colour theme: Reconnects with Caravaggio's theme, but contrast is even sharper with much greater detail. Composition utilises light, and lightest areas draw the eye. Light comes from the centre of the painting.

**Jacques Louis David** (French Neoclassical artist)

The Oath of the Horatii 1784/85

Oil on canvas

330 x 425 cm

Musee du Louvre, Paris



Picture from

Krausse, A. (2005). *The Art of Painting; from the Renaissance to the present*. Germany. Konemann

*Light and Colour theme:*

Light is used to draw the eye around the painting, ending on shiny reflections on swords that contrast against the dark background. Colour is now also used as a compositional element, bright red draws the eye, muted colours slip into the background.

**William Turner** (English Romantic artist)

The Burning of the Houses of Lords and Commons. 1833/5

Oil on canvas

92 x 123 cm

Philadelphia Museum of Art



Picture retrieved October 2014 from <http://www.ibiblio.org/wm/paint/auth/turner/>

*Light and Colour theme:*

Chiaroscuro is no longer used for contrast. Colour now contrasts against itself by use of complementaries. Careful attention is made of how light changes in reflections, with particular attention given to clouds and water.

**William Turner** (English Romantic artist)

The Fighting “Temeraire” tugged to her last berth to be broken up. 1838

Oil on canvas

91 x 122 cm

National Gallery, London



Picture retrieved October 2014 from <http://www.ibiblio.org/wm/paint/auth/turner/>









*Light and Colour theme:*

Colour now contrasts against itself by use of complementaries, but in this painting Turner also brings in some contrast between light and dark as well. Careful attention is made of how light changes in reflections and refraction, with particular attention given to clouds and water.

## Appendix C:

### Research log and analysis coding

#### Analysis Coding

-  Has doing an activity stimulated me to think about light and colour?
-  Has doing an activity stimulated me to feel experiences in relation to light and colour?
-  Has thinking about the subject inspired me to do the activity better?
-  Has having feelings about the subject inspired me to do the activity better?
-  Have I crossed the subject domains of Art, Science and Religion, through the process of thinking , feeling or willing?
-  Has the crossing of subject domains led me to heightened thinking, such as the consideration of ethics, aesthetics or epistemology?
-  Has the crossing of subject domains imbued me with deeper creative experiences, such as experiencing a flow of feelings, a metamorphosis of sense impressions, experiencing a sense of knowing through feeling?
-  Has the crossing of subject domains inspired me to set my will to the accomplishment of new virtuous goals, such as those that relate to truth, goodness and beauty?

# Research Log

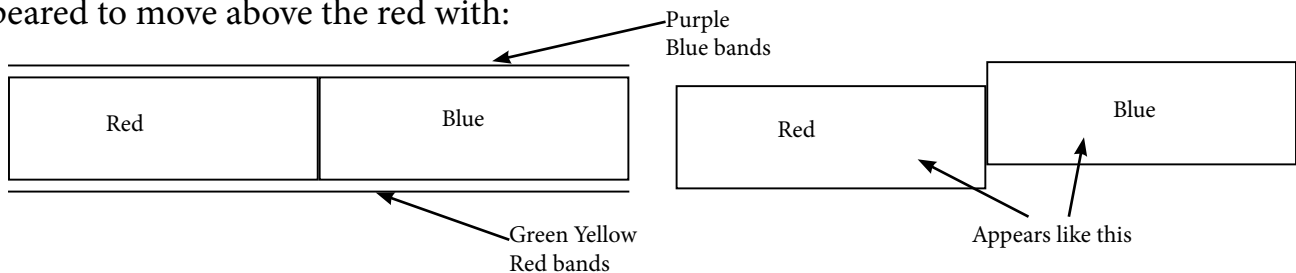
## Data based on Art, Science & Religion Activities

By Josephine Erskine

### Day 1- Descriptive Sampling Data

#### Science Experiment Day 1 (1st 15 mins)

I was reminded of Goethe's colour experiments with the rainbows appearing along the edges of the dark colour band. In this case light blue did not seem so different to red, but dark blue appeared to move above the red with:



#### Science Experiment Day 1 (2nd 15 mins)

The candle did not work, it did not seem bright enough, so I decided to use a torch with a direct light and shine this on the coloured paper.

#### Science Experiment Day 1 (3rd 15 mins)

The torch worked. I can see that the lines of cotton require a different focus point (as in photography) on the red than on the blue.

#### Science Experiment Day 1 (4th 15 mins)

It was difficult to find the right refraction angle but once I did it was easy to see how the colour proportions changed as the prism was moved up and down.

#### Art Work, Day 1 (1st 15 mins)

I thought I should simplify the picture down to just Jesus and Thomas. I noticed folds gently coming out of the darkness that were not noticeable at first glance, these reminded me of the way my eyes adjust in a dark room, like in the last experiment.

#### Art Work, Day 1 (2nd 15 mins)

I thought about how Thomas was drawn towards the light and how this had a philosophical or religious significance. Then I wanted to darken around what I had just been working on as darkening the surrounding area made the light brighter.



### Art Work, Day 1 (3rd 15 mins) ●

Drawing around the chest of Jesus I was thinking about the bone and muscle structure beneath.

### Art Work, Day 1 (4th 15 mins) ■ ●

As I drew the folds of the cloth I thought of how difficult this was to do. Then I moved on to the hand. I noticed the refraction, how the underneath was lighter than the middle because of light reflecting off the folds of the cloth below. This reminded me of the problem I had earlier in trying to understand how refraction through a prism worked.

### Literature choice, Day 1

When the mind is enlightened by Divine truth, and duly impressed with a sense of guilt, it cannot fail anxiously to inquire, how can a man be just with God.

*Justification part 1 parag1*

Dr. Charles Hodge

### Literature choice, Day 1 comment ● ★

‘Enlightened’ or to ‘light up’ is linked to ‘divine truth’. The quote suggests that this reveals something which makes us feel guilty, which in turn leads us to question how we can be better in God’s or the Divine’s all seeing eyes. This connects to the story of Thomas and his need to see, even touch before he could believe. The guilt he felt after this led him to have faith and be a better person. In the painting the area lit up is the part where he puts his finger into one of the wounds of Christ, further emphasized by the vectors which lead the eye to this spot. Thomas’s need to have physical proof through touch and sight then links to scientists of today who want to find physical proof to support belief in the divine. Light was associated with the divine - can this be explained physically?

### Action Research, Day 1

#### *How well do the practical activities work?*

Drawing works well for students with good drawing skills.

Difficult to hold the refracted rainbow in place for photograph, and candle was not a strong enough light.

#### *How can the practical activities be adapted to work better for this class?*

Blow up and focus on the hands for students with less developed drawing skills.

Using a torch instead of a candle worked better.

#### *Are there improvements in the way the practical activities are working?*

N/A

*How relevant are these activities to the overall lesson sequence?*

Drawing related to the science as it was being experienced, quote jumped out immediately.  
Very first experiment did not seem relevant.

*To What extent do these activities differ from previous ones?*

N/A

## Day 2 - Descriptive Sampling Data

### Science Experiment Day 2 (1st 15 mins)

(experiment 4) I felt impatient to get to the point, and read on to the next experiment.

### Science Experiment Day 2 (2nd 15 mins)



(experiment 5) Taking a photo I noticed that the image appeared white while what I was looking at was a beautiful range of colours. These then felt more spiritual, as if there was a special connection between the human eye and the splendor of what is seen by it, which can not be so readily recorded by means such as a camera. This reminded me of the purpose of original art works in relation of reproductions.

### Science Experiment Day 2 (3rd 15 mins)



Reading through the explanation given to exercise 5 I came to some understanding of what Newton was trying to achieve. Each colour was a replica of the circle of light, and the degree of refraction determined the colour seen. If each colour had been a beam of light in its own right, then this would be further refracted through a 2nd and 3rd prism, but this was not the case.

### Science Experiment Day 2 (4th 15 mins)

(experiment 6) This experiment was very difficult to set up as one person, and would need 3 at least to do it well. I did get to project a rainbow on the wall and using a card with a hole in it to isolate different colours.

### Art Work, Day 2 (1st 15 mins)

Drawing St Thomas' face, my mind began to wander to worries I had about finding a new place to live.

### Art Work, Day 2 (2nd 15 mins)



As I focused on Christ and Thomas's hands I thought of the anatomy of the hand. Then of how the darkness around the hands was needed to bring the hands out.



### Art Work, Day 2 (3rd 15 mins)

I **thought** about how my own worries kept creeping into my mind. I **felt myself battling** depression with optimism. I **wondered** if this was reflective of working with dark and light.

### Art Work, Day 2 (4th 15 mins)

I **felt happy** that the folds were mostly completed, and **didn't feel like stopping** until they were. I was gaining a **sense of satisfaction** with the work.

### Literature choice, Day 2

No light, but rather darkness visible  
Serv'd only to discover sights of woe,  
Regions of sorrow, doleful shades, where peace  
And rest can never dwell, hope never comes  
That comes to all; but torture without end.

*Paradise Lost Book 1*

John Milton

### Literature choice, Day 2 comment

My mind was kept free of worries **when concentrating** on the science, but when **working on** the art my feelings came to the fore, and with them worries I am dealing with. As I **battled these feelings** trying to turn them towards optimism, I began **to consider** how this relates to light and dark. The poetry by Milton reflected the **way I felt** when the worries overcome me. Light seems to go hand in hand with optimism, and the focus on light in the science showed that light was complete in its own right, and that colour was part of light, not something that would be separated from it. In the art I saw that darkness brings light out. In like way worries just amplify **optimistic feelings** when placed beside them.

### Action Research, Day 2

#### *How well do the practical activities work?*

The science experiment would be **too complicated to set up in a classroom**, many sets of hands would be needed and all with a clear knowledge of what they are trying to achieve. Drawing worked well, **but folds too difficult for some students to draw**.

#### *How can the practical activities be adapted to work better for this class?*

Blow up and focus on the hands for students with less developed drawing skills. Simplifying the experiment produced some results.

#### *Are there improvements in the way the practical activities are working?*

Torch works better than candle

### *How relevant are these activities to the overall lesson sequence?*

Important to demonstrate how colour does not create separate beams of light, but **experiment needs to be simplified** from Newtons to make workable in the class. What I succeeded in doing will work.

### *To What extent do these activities differ from previous ones?*

Previous exercises looked at how colour appears to move through refraction. These activities looked at how colour does not separate into separate beams of light, but are part of a whole. Drawing exercise is continuous, but experience is different when picture is near completion, to how it feels when starting.

## **Day 3 - Descriptive Sampling Data**

### **Science Experiment Day 3 (1st 15 mins)**

I decided to leave out experiment 8 due to difficulty setting this up as one person. Looking at the room, I wondered if the hole and sun were lined up well enough to do experiment 9.

### **Science Experiment Day 3 (2nd 15 mins)**

Finding it difficult to set up the experiments to suit the position of the sun, I tried to set them up with a strong torch, I had control, but could not get the reflection to separate into colours. Was this possibly because it was artificial light?

### **Science Experiment Day 3 (3rd 15 mins)**

Going back to the sun as a light source I was still having problems with getting a rainbow effect. I wondered if it was because it was cloudy. Then I saw a refracted set of rainbows through a smaller prism coming in through a series of smaller holes. I was then able to observe how each hole refracted its own range of colours, separate from each other. And that the blue/violet side showed a greater refraction in each case.

### **Science Experiment Day 3 (4th 15 mins)**

(experiment 10) I could only project white light somewhat defused. I wondered if this is because colour can only come from bright light, and wondered if this is why colours look washed out under moonlight. Looking through the prism I could see refracted colours, but not in the reflections which were a weaker light.

### **Art Work, Day 3 (1st 15 mins)**

**I thought** about how my mind wanders and **contemplates** various things going on in my life at present. I began to **contemplate** how the artwork compliments the science work, then I realized I was doing this because this is what I'm looking for, rather than because it was a natural occurrence.

### Art Work, Day 3 (2nd 15 mins)

My mind wandered again to possible houses I might be able to live in. I then contemplated how drawing relaxed me, calmed me, so I could contemplate that which was worrying me, and which I kept pushing aside, I wondered if it would do this with a question that concerned me in relation to science?

### Art Work, Day 3 (3rd 15 mins)



I was thinking about how light falls around the folds of cloth, and felt a mix of anxiety and satisfaction as each fold is drawn and works, or needs adjusting.

### Art Work, Day 3 (4th 15 mins)



Doing the finishing touches I became more aware of the subtleties of shades between the darkest and lightest areas. This reminded me of the clearer graduations I see when in a darkened room (as in the previous experiment) and how when looking at the light, the subtleties slowly reveal themselves.

### Literature choice, Day 3

Therefore the highest and most general problem of philosophy is exclusively this - to apprehend and fix the essential in that fleeting chaos, to display it as the essential and good therein, and so drawing forth to the full light of consciousness the apparent contradiction between those two intuitions, to reconcile it at the same time.

*Introductions to the Dialogues of Plato p171*

Schleiermacher

### Literature choice, Day 3 comment



In drawing the folds of cloth I experienced fleeting chaos, each time I looked at the graduations of tone, the essential appeared to move, I had to fix it. But when I did, the effect was too harsh and I needed to blend, in order to reconcile the problem. Finding the essential in this way was similar with the experiments, I could predict what would and wouldn't work, and pulling out the essential from each experiment, I made adaptations to make them work more smoothly. However sometimes this didn't work, and I needed to refer back to the original experiment.

### Action Research, Day 3

*How well do the practical activities work?*

The experiments are becoming too complex for a class.

I wonder how easy it would be for students to do the drawing task in comparison with myself. Where my mind has wandered or pondered because I find the work easy and relaxing, a student might find it difficult, and it may cause anxiety.

*How can the practical activities be adapted to work better for this class?*

Adaptations I have made to simplify the experiments have meant that I have discovered more successful ways to conduct the earlier experiments.

A range of drawing exercises would need to be developed for students at different ability levels. Important to provide work that is both challenging and satisfying.

*Are there improvements in the way the practical activities are working?*

More practice has meant that I am getting better at finding the right angles for refraction. In artwork the process is working well for me, and would be a similar experience for those students who have advance skill in drawing, but for other students to have a similar experience, the drawing activities would need to be simplified, so that the right balance between challenge and satisfaction is achieved.

*How relevant are these activities to the overall lesson sequence?*

In many respects these lessons are simply a continuation, or extension of what was done previously, rather than being something new.

*To What extent do these activities differ from previous ones?*

The activities are much the same, but what does jump out as different is the literature and experience in relation to fixing the essential, in chaos.

## **Day 4 - Descriptive Sampling Data**

### **Science Experiment Day 4 (1st 15 mins)**

Using a torch with a small hole to let light through I found this more controllable than using the sun through a window. Able to get good shots with the camera. Could not get separation of colours like Newton in experiment 11.

### **Science Experiment Day 4 (2nd 15 mins)**

Reading over Newtons notes I felt uncomfortable with the pedanticness of his scientific method. In experiment 15 the angles of the refraction positioned at various points all met with the same point in projection - this reminded me of single point perspective.

### **Science Experiment Day 4 (3rd 15 mins)**

Working with a rectangular hole for the light source I found it made a long spectrum, but little of real interest.

### **Science Experiment Day 4 (4th 15 mins)**

Reading through the next experiments I found little more of interest in regards to upper school lessons. Seemed more a hammering of the point already made. This degree of scientific precision feels very deadening, and uninteresting.

#### Art Work, Day 4 (1st 15 mins)

In establishing the overall layout of the picture, as I had decided to simplify it, I wondered about the significance of the sheep which I had decided to keep as a compositional element, rather than for symbolic value. I then **became engrossed** in the curvature of the horse, which **I felt** was not so much realistic, but geometrically exaggerated to show movement and grace.

#### Art Work, Day 4 (2nd 15 mins)

Applying a background from pencil shavings I **became aware** of how quickly a flood of colour can change the overall mood of the painting.

#### Art Work, Day 4 (3rd 15 mins)

Working with a yellow/brown pencil I started putting in the contours of the Eros figure in the yellow. **I became aware** of the **joy experienced** in giving form to yellow, intensifying it.

#### Art Work, Day 4 (4th 15 mins)

**I wanted** to continue working after 15 mins - which I did, as **I felt** a **strong need** to balance the blue and yellow tones before stopping. Just as the eye needs to balance itself with the after-effect of an opposite colour. To have left this unbalanced would have caused a frustration - a kind of pain. The process became somewhat addictive and I could easily have continued further, but **felt satisfied** enough after balancing the yellow and blue in the area I was working on, and **disciplined myself to stop** there.

#### Literature choice, day 4

All night the dreadless Angel unpursu'd  
Through Heav'n's wide Chanpain held his way, till Morn,  
Wak't by the circling Hours, with rosie hand  
Unbarr'd the gates of Light. There is a Cave  
Within the Mount of God, fast by his Throne,  
Where light and darkness in perpetual round  
Lodge and dislodge by turns, which makes through Heav'n  
Grateful viscissitude like Day and Night;  
Light issues forth, and at the other dore  
Obsequious darkness enters, till her houre  
To veile the Heav'n, through darkness there might well  
Seem twilight here; and now went forth the Morn  
Such as in highest Heav'n, arrayed in Gold  
Empyrean, from before her vanish Night  
Shot through with orient Beams: when all the Plain  
Coverd with thick embattld Squadrons bright,  
Chariots and flaming Armes, and fierie Steeds  
Reflecting blaze on blaze, first met his view.

*Paradise Lost Book 6*  
John Milton

## Literature choice, Day 4 comment

The play between dark and light, and the imagery of a golden fiery steed charging through the light area **was well reflected** in this piece of poetry. While the picture worked on showed a curtain being pulled across the bright sun filled area, this poem describes a dark cave in the residence of god. Whether in the poem, the painting or the science, light is active, but needs darkness to show its gory.

## Action Research, Day 4

### *How well do the practical activities work?*

Simplifying the painting works well for developed students, but will need more simplification for others.

Science experiments much easier to achieve with a torch.

### *How can the practical activities be adapted to work better for this class?*

Simple yellow blue and black colour exercise would work well for less able students. With exercise done would develop multi media as well as drawing ability in more able students.

### *Are there improvements in the way the practical activities are working?*

Torch works better than hole in blind for sun.

Simplified picture is better than painting original as it is.

### *How relevant are these activities to the overall lesson sequence?*

Painting gives a very good feeling for yellow as the lightest colour, and blue or blue/purple as its complimentary. A very good way to experience the liveliness of yellow and the sleepiness of blue. Reflects colour experiments in general. Poem reflects this very well.

### *To What extent do these activities differ from previous ones?*

New art technique and picture works well with the content. Poem works well and explores colour rather than just dark and light. **Science experiments are getting monotonous and need to select some from the many that show distinct changes, or observations.**

## Day 5 - Descriptive Sampling Data

### Science Experiment Day 5 (1st 15 mins)

(part 2 experiment 1) I was able to produce a spectrum, and using card with a hole in it was able to isolate parts of the spectrum so that when totally immersed in the blue I got a blue light isolated. I was able to do likewise with the red. But when I isolated the white area I got red white and blue.



### Science Experiment Day 5 (2nd 15 mins)

Tilting the paper on which a spectrum is cast I can get blue if I tilt the paper one way, and red if I tilt it the other. (exp 2 part 2). This **reminded me** of how coloured shadows work.

### Science Experiment Day 5 (3rd 15 mins)

Using a range of objects that reflect or absorb light, I placed objects under the projected light. What was green light remained green, likewise with red, yellow and blue. The objects that reflect colours (such as metals) reflected the colour back the same colour, unchanged.

### Science Experiment Day 5 (4th 15 mins)

Putting paper next to the projected spectrum I can see that red reflects red light onto the paper, and blue reflects blue. This **reminds me** of coloured light on objects at sunset.

### Art Work, Day 5 (1st 15 mins)

Shading the horse around the back and rump I **become aware** of how the colour markings on the horse matched the colour in the darkest parts of the clouds. This **reminded me** of the reflection experiments done previously. The colour of the horse is reflected from the clouds. However the rump of the horse was much darker than would naturally have been the case in this scene. The Artist has deliberately darkened the area which sits in the brightest part of the yellow background, creating more contrast here, so that the horse stands out.

### Art Work, Day 5 (2nd 15 mins)

I note that the front of the horse is lit up as if by the sun, but the sun is Apollo sitting behind the horse. The clouds reflect Apollo's light, but the horse has its own light, as if lit up by stage lighting to bring the character of the fiery steed out.

### Art Work, Day 5 (3rd 15 mins)

Working now on the figure drawing the curtain I start **thinking** about the difference between the academic work I am doing, and the teaching work I do. This moves into **thinking** about the people involved in these different circles and approaches they take on **thinking**. I observe the positive and negative aspects of the **thinking** approach of both.

### Art Work, Day 5 (4th 15 mins)

I **felt great satisfaction** drawing in the curtain using oil pastels. The density of the colour was a great **feeling of certainty and solidness** against the soft coloured pencil work of the sky. They **felt more clumsy** to use compared with the pencils, and required courage to put the line down against the sky. The experience is one of balance - good and bad, strong and delicate, heavy and light, as well as dark and light. **It reminds me** of various philosophies that contrast with each other.

## Literature choice, Day 5

As in the stellar firmament there are sometimes two suns which determine the path of one planet, and in certain cases suns of different colours shine around a single planet, now with red light, now with green, and the simultaneously illumine and flood it with motley colours: so we modern men, owing to the complicated mechanism of our “firmament”, are determined by DIFFERENT moralities; our actions shine alternately in different colours, and are seldom unequivocal - and there are often cases, also, in which our actions are MOTLEY-COLOURED.

*Beyond Good and Evil* parg. 215

Friedrich Nietzsche

## Literature choice, Day 5 comment



In **thinking** about the different way that academics I know and the Waldorf teachers I work with **think**, I found this passage of Nietzsche corresponded with the different kinds of thinking these groups of people have. My **thoughts** were then turned more toward different moralities, and this then linked in with the colours which seem to reflect different moral aptitudes. The red and the blue in the painting create quite **different feelings**, and symbolize quite **different forms of thinking**. This could also **be related** to different forms of morality.

## Action Research, Day 5

### *How well do the practical activities work?*

The science experiment was fairly easy to replicate.

Use of coloured pencil and use of pastel makes it easy for students to get a feeling of contrast, as well as an experience of different forms of media.

### *How can the practical activities be adapted to work better for this class?*

All working well, but an easier artistic exercise using the same materials could be developed for less able students.

### *Are there improvements in the way the practical activities are working?*

Use of mixed media exaggerates the art experience, allowing the experiences to grow in intensity.

### *How relevant are these activities to the overall lesson sequence?*

Science experiments are a comfortable step forward from others. Painting and Literature correspond loosely with each other, and with science experiments in general.

### *To What extent do these activities differ from previous ones?*

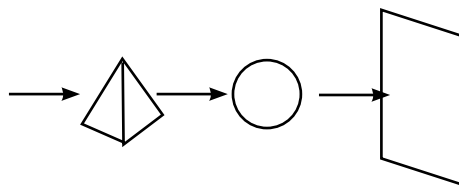
Science experiment is a good step on from previous ones. Art and Literature progress the idea of colour rather than just dark and light, and merge this with morality.



## Day 6 - Descriptive Sampling Data

### Science Experiment Day 6 (1st 15 mins)

Reading through the experiments I began to **get more excited** about them, they seemed to be proving that all colours created white light.



### Science Experiment Day 6 (2nd 15 mins)

I successfully set up an experiment and was able to show the spectrum converging to a point of white and then by moving the paper further back it would enlarge again with the colours reversed.

**Science Experiment Day 6 (3rd 15 mins)**    Original With blue white and Red bands.     Now with blue, white and red band on every strip.

Placing a light through a prism then a lens and projecting an image on the wall. I then put a comb against the prism intercepting the light. Observing this **I was excited** by it artistically **wanting to try out** a painting where silhouettes of complex shapes take on different colours according to this science.

### Science Experiment Day 6 (4th 15 mins)

Moving the comb up and down quickly I see a blur of colours. It was **aesthetically wonderful!** But I didn't see the colours combine to make white unless I blurred my eyes. Blocking off blue or red spectrum deliberately meant that the blue (if that was the one blocked) moves down so it is always blue at the edge of darkness. Likewise with red but only one side moves at a time. **This could be done** in a class with interesting shapes.

### Art Work, Day 6 (1st 15 mins)

This beginning of a new painting had me **concentrating** on the divisions and proportions and dividing up the page. **I thought** about what under colours needed to be blocked in first. Then **I considered the process of teaching** this to students.

### Art Work, Day 6 (2nd 15 mins)

Painting in the features of the face I experienced deep levels of **sympathy** for the figure I was drawing. His stern features reminded me of my grandfather. Was this the European features, or was it the look of a man who had faced war, that I connected with my grandfather? I found myself tenderly smoothing in and bringing out the deep lines around the mouth, imagining what will this man must have had.

### Art Work, Day 6 (3rd 15 mins)

Doing the finishing touches to the face **I became aware** that what appears to the eye to be a brown patch is in fact a layer of colours - red brown - brown with black in the center. I had built up layers of red/brown and brown over skin colour for the contours in the cheeks. But even these areas appeared to have no black in them, yet looked odd until the black was added. **It reminded me** of the experiment where colours are rebalanced according to what we see. The black was necessary, but was not seen in the final combining of colours by the eye.

## Art Work, Day 6 (4th 15 mins)

Working on the helmet now I started seeing the faint nuances of colour sitting over the black background, providing the eye with a subtle clue as to the rest of the form sitting hidden in the darkness. Just a faint swish of colour and the eye/brain can put the rest of the picture together. And yet it is **more satisfying** to put it together this way, than to paint it all in. Is this because we become **active in the process**, and the activity triggers more inner activity which leads to **satisfaction**, while still leaving room for wonder?

## Literature choice, Day 6

That sun never sets: nor suffers any cloud, but such as are raised by our passions. It is a day without shadow. It lights the savages even in the deepest and darkest caves; none but sore eyes wink against its light; nor is there indeed any man so distempered and so blind, but who still walks by the glimpse of some duskish light he retains from that inward sun of consciences. That universal light discovers and represents all objects to our minds; nor can we judge of anything but by it; just as we cannot discern anybody but by the rays of the sun.

*The Existence of God Sect. LVIII*

François de Salignac de La Mothe-Fenelon

## Literature choice, Day 6 comment

Light is here again **compared** with a higher consciousness or God. One which can only be dampened by our own passions. Here walking in ones own light of **consciousness or intellect** is but a dim and depressing shadow. He says that judgment can only be made from a higher consciousness. In this sense I saw a connection between the coloured spectrum which converged to make white light, and could then reverse to make the opposite spectrum. As if the white represented the whole, from which things are seen neutrally, while the colours represented the coloured nuances, likened to our passions, through which we view the world, and organize our **intellect**.

## Action Research, Day 6

### *How well do the practical activities work?*

The science experiment worked well.

The art activity is a good step up from the previous one. **But a simplified one also needs to be developed for less able students.**

### *How can the practical activities be adapted to work better for this class?*

Less able students could work on a section of the helmet contrasting this with the dark background. Would be good to show how slight colours in the background complete an image in the minds eye. This can be done with details on the helmet.

Science experiment could be combined with use of coloured filters to show more easily how white light is formed when colours mix.

### *Are there improvements in the way the practical activities are working?*

Using chalk pastels takes the next step in layering, and can act as a transition to painting which requires more skill.

Science experiments are becoming more substantial and clear.

### *How relevant are these activities to the overall lesson sequence?*

Both activities are very relevant, but literature takes things onto a different level which is more philosophical, but not necessarily related other than in white light representing a whole.

### *To What extent do these activities differ from previous ones?*

New media in the art. More focus on light and dark, less about colour.

Science experiment shows the connection between colours and white light.

Literature takes a philosophical jump forward.

## **Day 7 - Descriptive Sampling Data**

### **Science Experiment Day 7 (1st 15 mins)**

Reading through the experiments I didn't think mixing pigments in water could produce a whitish colour if diluted enough. But was **keen to try** and **understand** that pigments which reflect a colour can if diluted in water be used as a filter to allow only that colour ray to be passed through.

### **Science Experiment Day 7 (2nd 15 mins)**

The light through watered down green shone a dark green on the wall, the red did the same only the red on the wall was darker still. Green seems closer to a white light. Shining a light through both I got a solid black shadow. This made me think of how red and green lights produce shadows. I was also **fascinated** with how looking at the light through the green water it appeared bright green, but looking at the light as it shone into the green it appeared pink. I **thought** I might get the same result from the red in reverse, but looking at the light as it shone into the red it appeared yellow to green as **I had supposed**.

### **Science Experiment Day 7 (3rd 15 mins)**

In any light the bubbles in a dish reflect tiny spectra in each glistening spot if looked up close, but from a distance they appear white, **I wonder** if painting a spectrum of colours together will have the same effect in a painting when viewed from a distance. Looking at a crystal **painting I made** on the wall I saw that in a dim light this was indeed the case, however the tiny spectrum's I had painted were in patches of white, **Thinking** of my painting experience of how a tiny mark of brown and black can make an image seem the right tone, even though they can't be distinguished as their own colour **I wondered** if the effect would be more of a gray had the white not been there.

### Science Experiment Day 7 (4th 15 mins)

Playing with two spectra and running them across one another was a **delightful experience**. Playing with the refractions **made me want** to create artworks out of pure light. I found that bringing the red of one down over the purple of the other I was able to create a perfect magenta. I tried to make cyan and yellow but could not as the bands of colour would need to be bigger.

### Art Work, Day 7 (1st 15 mins)

I was **completely focused** on the rounding of the helmet. The graduations from gold to brown/red to black and how the shadows around the ornamentation moved as they moved away from the central part of the reflection of light.

### Art Work, Day 7 (2nd 15 mins)

First I saw the lit up areas and their details, then as I looked at the darker areas I saw more details in here that I didn't see at first, as the alarm rang I stood back and saw that the red/brown had taken over the gold and **I realised** that my sight changes according to what **I focus** on, and this applies as much to colour variations as it does to focusing on long and short distances.

### Art Work, Day 7 (3rd 15 mins)

Putting in the white highlights and black undertones **I felt an amazing sense of satisfaction**. The helmet was starting to take on the shape of a real ornamental helmet with dramatic reflection. The process requires absolute **attention to detail** and highlights refract off one shape and reflect on others so that there is the odd highlight even in the deepest darkness.

### Art Work, Day 7 (4th 15 mins)

I added flicks of yellow by the white highlights which gave the overall appearance of gold - before with just the white it looked shiny but not gold. I was reminded of the bubbles in the experiment how they looked white in the reflections but on close contact they had a spectrum. Though no yellow could be seen in the painting by adding the flecks of yellow, it changed the appearance to look like gold in the painting.

### Literature choice, Day 7

But among those stars I perceive the moon, which seems to share with the sun the care and office of lighting us. She appears at set times with all the other stars, when the sun is obliged to go and carry back the day to the other hemisphere. Thus night itself, no with standing its darkness, has a light, a duskish indeed, but soft and useful. That light is borrowed from the sun, though absent: and thus everything is managed with such excellent art in the universe that a globe near the earth, and as dark as she of itself, serves, nevertheless, to send back to her, by reflection, the rays it receives from the sun, and that the sun lights by means of the moon the people that cannot see him while he must light others.

*The Existance of God Sect. XVIII*

François de Salignac de La Mothe-Fenelon

## Literature choice, Day 7 comment

A duller light, that of the moon is described here as carrying out the work of the sun on a lesser scale while the sun is busy lighting up others. The moon is described as a retractor of the sun's light. **This is like** the refractions seen on the helmet in the painting. It does not show so much the science experiments.

## Action Research, Day 7

### *How well do the practical activities work?*

Some science experiments worked better than others and need to be sorted for use in a class.

The art ones work well, the concentration on the helmet would work for all levels of art ability in the class

### *How can the practical activities be adapted to work better for this class?*

These could easily be carried out in the beginning of an art lesson, as they relate to objects found in this environment. Mixing coloured water to make white can be shown in an art class, but note that Goethe explained why this did not make a pure white and only a light gray when the water was weak enough.

Would need to get a high quality original and blow it up to show helmet in detail for less able students.

### *Are there improvements in the way the practical activities are working?*

Using chalk pastels takes the next step in layering, and can act as a transition to painting which requires more skill.

Certain experiments need to be selected to maintain clarity of science experiments. I would prefer to use coloured filters with different light sources to show colour change.

### *How relevant are these activities to the overall lesson sequence?*

**Both activities are relevant, but not necessarily to each other.** Literature works with the activity of colouring the helmet.

### *To What extent do these activities differ from previous ones?*

Continues on from last session but more focus on refraction of light on helmet.

Science experiment shows relationship between spectrum's and white light. Is not working with reflection as other activities in this session are.

Literature looks at refraction of the sun's light through the moon.

## Day 8 - Descriptive Sampling Data

### Science Experiment Day 8 (1st 15 mins)

Doing Goethe's experiment 167 with coloured milk I was able to produce the effects of a dull blue with light shining indirectly in front, and a dull yellow with light directly behind. **I felt disappointed** that the experiment was not more spectacular, and colours brighter.

### Science Experiment Day 8 (2nd 15 mins)

Doing experiment 170 I used a paper towel and folded it in front of a light, I was able to get a bright white/yellow to gradually change to a dull red. This seemed **more satisfactory** for what was involved. I decided to try this in evening light looking through the paper at the light on the ceiling. With one layer I saw a dull yellow, but with all 3 all background light was wiped out and I saw a pale blue because of the light between me and the paper.

### Science Experiment Day 8 (3rd 15 mins)

Looking at the black and white images supplied through a convex glass and pulling back so they were unfocused created a slight effect of reddening and bluing along the edges. This **re-minded me** of the sfumato effect in painting and I wondered if bluing and reddening the edges could be used to do this in art. The overall effect was not spectacular, but looking through the prism was with distinct bluing where white moved down over black, and reddening where black moved down on white. **This was spectacular.** I began **to think** about all the rays being drawn in and absorbed by black and reflected by white, and that the refraction was showing me the individual rays or colours.

### Science Experiment Day 8 (4th 15 mins)

Looking around the room with the prism I was able to get an even more spectacular effect looking at dark objects on a white wall. The blue at the bottom turned into green and then yellow over quite a wide area. And the red at the top moved into orange. The colours flooded into the object and the whole thing **looked beautiful.** Like all things beautiful I was **stimulated to paint it.**

### Art Work, Day 8 (1st 15 mins)

Looking at the clothing there is a lot of guess work required as only faint highlights from the clothing can be seen. This means I was **concentrating** hard on the lines indicated by tiny faint highlights, trying to see in my imagination where they line up and what focus they create. This involved much inner activity.

### Art Work, Day 8 (2nd 15 mins)

Adding finishing touches to the clothing I see repeating highlights that fall in lines from rays of light. Shadows which at first seem random begin to make logical sense and I can see how a black line put not in quite the right place can interfere with the eyes ability to recreate the whole shape in the imagination.

### Art Work, Day 8 (3rd 15 mins)

Now that the extreme contrast has been created for the clothes and helmet I realize that the face has too much light on the shadow side. Adding darkness bit by bit I realize how much more careful and delicate I am when working with a human face.



## Art Work, Day 8 (4th 15 mins)

I darkened much of the shadow area of the face bringing the shadow areas to a common density over the whole picture. I noted how the under of the cheek in the shadow area was completely defused into the dark background and imagined that this is where the light defused and refracted from the main source, would be completely non-existent below the shadows

## Literature choice, Day 8

No literature was chosen on this day.

## Literature choice, Day 8 comment

No literature was found to jump out on this day.

## Action Research, Day 8

### *How well do the practical activities work?*

These experiments worked, but the refraction ones outshone the others.  
The art was a continuation of previous work and worked well.

### *How can the practical activities be adapted to work better for this class?*

The refraction exercised would work better with a more modern painting. The seeing light through folded layers of paper worked well with this painting which works with subdued layers. So a reordering of experiments would work better.

### *Are there improvements in the way the practical activities are working?*

Using chalk pastels takes the next step in layering, and can act as a transition to painting which requires more skill.

Certain experiments need to be selected to maintain clarity of science experiments and to keep link with experiences in art works.

### *How relevant are these activities to the overall lesson sequence?*

Both activities are relevant, but not necessarily to each other.

### *To What extent do these activities differ from previous ones?*

Continues on from last session but more focus on changes of dark and light in relation to overview of finishing touches.

Science experiment shows relationship between dark and light edges, and layering.

## Day 9 - Descriptive Sampling Data

### Science Experiment Day 9 (1st 15 mins)

By enlarging the bands through angling the refraction I am able to get the effects on plate 2 figure 5, using a black stripe on white or the reverse. It would **be interesting** to **try this on a raised object** as the candle holder on the wall produced a better effect than coloured paper yesterday. **Interesting** to see this in relation to different objects.

### Science Experiment Day 9 (2nd 15 mins)

**I was interested** in how in orange - yellow - white - blue - purple the white becomes green when the colours expand over the white. And how in blue - purple - black - orange - yellow the black becomes red when the colours expand. So black becomes red and white becomes green.

### Science Experiment Day 9 (3rd 15 mins)

**The idea** that gray on white behaved like black when looked through a prism, and gray on white behaved like black really **interests me**. It means that the phenomena of colour adjusts to suit different situations, which **I find refreshing**.

### Science Experiment Day 9 (4th 15 mins)

Looking at the blue and the red square on black, both acted as white but red was much more solid while blue appeared to move upwards and become shorter as the green below it seemed to push in on it, and the purple above to extend it. **I realised** that this is different from what Goethe described, but from what I discovered yesterday, it depends which way up I look through the prism.

### Art Work, Day 9 (1st 15 mins)

As I arranged the layout I was **thinking about** the rule of the golden section in creating the composition. I decided the paper will need to be shorter at the bottom for the sections to fit well. I have arranged a back and a side light as the Baroque artists use. Vectors on the vase will lead to the window - trees outside will need to be arranged to bring the eye back in to circle the work and see the reflection.

### Art Work, Day 9 (2nd 15 mins)

Mixing up the colour for the back wall and applying it I was struck by the range of shades that existed in what at first appeared a flat colour. Then **I noticed** a slight yellow to the brown/black shadow band behind the window frame - a very slight refraction.

### Art Work, Day 9 (3rd 15 mins)

Applying the colours for outside the window **I felt frustrated** that the acrylics I am using can't achieve the colour range or 'light' range that I can see in reality. The white is so much darker than the light. It **reminds me** of the dull coloured blue and red light reflections achieved by shining light through watery paint jars.



## Art Work, Day 9 (4th 15 mins)

Playing with the clouds and green trees I was able to create a compositional curve vector that leads the eye back into the painting. Otherwise the vector of the top of the vase against the background would have led the eye out of the window and off the page. **Observing** this I saw how bright pure colours act as arrows among muted colours. So I used pure blue, white and yellow to create the vector that led the eye back in.

## Literature choice, Day 9

Therefore the highest and most general problem of philosophy is exclusively this - to apprehend and fix the essential in that fleeting chaos, to display it as the essential and good therein, and so drawing forth to the full light of consciousness to apparent contradiction between those two intuitions, to reconcile it at the same time.

*Introductions to the Dialogues of Plato p.171*

Schleiermacher

## Literature choice, Day 9 comment

Just as colour changes according to where it is positioned, and behaves differently according to where it is positioned, so too does this happen in art, in the selection of strong or light tones as well as colours when placed beside each other. This is also reflective of forms of **philosophical thought**. There is a need to pick what stands out, and name this the essential thing out of a mass of chaotic thought, but this essential thing can be good, or not good depending on what the **thought** is placed beside.

## Action Research, Day 9

*How well do the practical activities work?*

**It would not work for each student to set up there own still life**, but some could do this after instruction on Baroque art composition as it would be a good skill for them to learn.

The science activities would just need the page from Goethe's book and enough prisms to have one each. This could be easily arranged in an art class at the beginning.

*How can the practical activities be adapted to work better for this class?*

Mostly the student would work from a picture of my painting. In other cases they could photograph their own still life composition and work from the photograph.

*Are there improvements in the way the practical activities are working?*

In art the students are progressing to working with acrylic paints and learning brush skills and colour mixing skills.

Experiments could be ordered to better match experiences in the painting sequence.

### *How relevant are these activities to the overall lesson sequence?*

Both activities are relevant. Science ones are particularly so, art will be more so once more of it is underway. Literature works particularly well with science experiment.

### *To What extent do these activities differ from previous ones?*

Acrylic paint techniques, brush skills and composition are learnt in the art.

More detailed experiments demonstrating how colour changes in different settings is shown in science. Literature has been used before, but is very fitting with the science here.

## **Day 10 - Descriptive Sampling Data**

### **Science Experiment Day 10 (1st 15 mins)**

Looking at experiment 271 I used a selection of cut out pieces of paper. The colours I used were not the same as those of Goethe so I found the results slightly different but the lighter the colour, the stronger the colour band and the more the displacement of the image.

### **Science Experiment Day 10 (2nd 15 mins)**

Putting colour squares on white and looking at them through the prism again received best results when the colour contrast is greatest.

### **Science Experiment Day 10 (3rd 15 mins)**

Putting colours between black and white base was the most interesting - gray as the most mid tone of the colours I used worked best with red on top over the black, and blue below - reversed on the white side showing one side of the gray square displaced from the other. I wondered how this might effect painting and **thought** of the displacement on reflections and how until now I had not been able to follow the logic of how these worked simply trying to copy them, but as I observed in drawing the clothing of Rembrandt's painting - if I can't follow the logic of what lines link up, the overall effect looks odd and not quite right. This is what happens to my drawings of reflections.

### **Science Experiment Day 10 (4th 15 mins)**

Yellow on black was the most resplendent which is interesting because painted together the colours are jarring and give a disturbing quality. However refracted the top moves into yellow then violet and below from blue into green. I imagine painting yellow like this when on black would alter the effect and make it **beautiful rather than disturbing**. All colour combinations can be beautiful when painted if the right way to paint them is found.

### **Art Work, Day 10 (1st 15 mins)**

Bringing in the gold base for the bronze jar **I feel a sense of satisfaction** at the colour balance between the gold and the blue. The blue/white of the window frame acts as a gentle transition.

### Art Work, Day 10 (2nd 15 mins)

Working on the bronze the subtleties were **very beautiful** and remind one of the graduations of soft light in darkness. A further study reveals that a paler yellow and darker brown are needed to meet the colours of the bronze in reality.

### Art Work, Day 10 (3rd 15 mins)

Working with the reflection I now need to bring darkness to the rest of the shadows on the vase. Interesting to observe the elongation of the distorted reflection.

### Art Work, Day 10 (4th 15 mins)

Darkening up the vase it becomes much more obvious where highlights that could not be seen before now lay. **I wondered** about refraction on the reflection of myself. On **close inspection** there was a slight colouration of blue to the light side and yellow/red to the dark. **I decided to paint this in** - the effect was more exaggerated than reality but it made the reflection look more like it was supposed to be.

### Literature choice, Day 10

My former views look like the gloomy boarding of a playhouse when the lights have been removed. My heart sought a philosophy, and imagination substituted her dreams. I took the warmest for the truest colouring.

*Schillers Philosophical letters - letter IV*

Friedrich Schiller

### Literature choice, Day 10 comment

After struggling in painting reflections and refractions simply by observation without understanding them, the above quote seemed to demonstrate **my thinking**, which was in relation to this science, like a gloomy unlit playhouse, **in comparison** with the thinking with which I can now support my observations of this phenomena.

### Action Research, Day 10

*How well do the practical activities work?*

The science ones work very easily in a class.

**The art ones would be complicated for some.**

*How can the practical activities be adapted to work better for this class?*

There would be a need to simplify some composition to just the refracted reflection in a shiny object, and photograph this for the students to use.

*Are there improvements in the way the practical activities are working?*

Developing painting skills to paint the delicate refraction would involve a new skill of feathering with coloured glazes.

experiments are straight forward and easy to see.

*How relevant are these activities to the overall lesson sequence?*

Both activities are relevant, and are relevant to each other in some respects. Literature is more relevant to the thinking that is experienced rather than the activities themselves.

*To What extent do these activities differ from previous ones?*

Painting develops a new painting skill of feathering.

Science intensifies earlier experiment looking more intently at colour varieties.

Literature jumps to the philosophical.

## **Day 11 - Descriptive Sampling Data**

### **Science Experiment Day 11 (1st 15 mins)**

I found that I achieved the opposite to Goethe in respect to my iron wire achieved ring highlights in the sunlight but this was because it was a very cloudy day and the effect was that of Goethe's defocused light in the camera obscura. I achieved ring light by holding a torch to the wire in a dark cupboard. I would be more comfortable using the terms strong light and defocused light.

### **Science Experiment Day 11 (2nd 15 mins)**

In doing activity 373 I used the shiny bronze bullet and smudged a finger print over it. This shone iridescently in the light from the overcast day. It stood out more in the darker reflections, so in holding up black paper I was able to show it well. The effect was satisfactorily easy to reproduce, and **I can imagine how I could use this** in an art class to demonstrate the reflection.

### **Science Experiment Day 11 (3rd 15 mins)**

Re-reading Goethe's description I realized I hadn't seen colours only a glow. **So I tried** the experiment on other brass ornaments, pots, cooking utensils etc. **I tried** putting oil on these. Oil was too smooth and so were the polished surfaces I was using. The cheese grater worked best due to the fat of the cheese, in this I saw iridescent blues and yellows. I also looked at these through a lens.

### **Science Experiment Day 11 (4th 15 mins)**

Trying out simpler experiments on mirrors I found that the grubby marks left on them worked better than cleaning them and putting on new marks. The marks had to be of a thick greasy constituency, then I breathed on the mirror and could watch as blue slowly changes into yellow and orange. I could only see flickers of green in small pre existing marks.

### Art Work, Day 11 (1st 15 mins)

It was an **unusual feeling** working on this today as I kept seeing my reflection in the painting but the reflection didn't move when I did. Painting the pale blue I had **a sense of inner satisfaction** that the colours were now in balance.

### Art Work, Day 11 (2nd 15 mins)

Working with the shadows I had to think scientifically about the fall of the shadows the diffusion and how this worked with the fall of the cloth.

### Art Work, Day 11 (3rd 15 mins)

Painting the rippled silk was quite difficult it tended to look like a wavy sea and **needed to be** calmed down a lot.

### Art Work, Day 11 (4th 15 mins)

Bringing more tone into the background wall I was able to bring the vase out more and differentiate between the window and wall. Here there was an artistic deviation from the reality but one which brings the picture into a whole.

### Literature choice, Day 11

Let us, in the first place, stop at the great object that first strikes our sight, I mean the general structure of the universe. Let us cast our eyes on this earth that bears us. Let us look on that vast arch of the skies that covers us; Those immense regions of air, and depths of water that surround us; and those bright stars that light us. A man who lives without reflecting thinks only on the parts of matter that are near him, or have any relation to his wants. He only looks upon the earth as on the floor of his chamber, and on the sun that lights him in the daytime as on the candle that lights him in the night. His thoughts are confined within the place he inhabits. On the contrary, a man who is used to contemplate and reflect carries his looks further, and curiously considers the almost infinite abysses that surround him on all sides. A large kingdom appears then to him but a little corner of the earth; the earth itself is no more to his eyes than a point in the mass of the universe.

*The Existence of God sect. X. of the general structure of the universe*

François de Salignac de La Mothe-Fenelon

### Literature choice, Day 11 comment

The artistic and science activities led me **deeper into thinking**. This seemed well reflected in the literature which was about reflection. To ponder and consider and reflect deeper things than that which lay around me, or to look deeper into things than just what immediately meets my eyes. This opens up a whole universe.

## Action Research, Day 11

### *How well do the practical activities work?*

Some of the science experiments were not reliable, and would need a lot of preparation to find the right items. The mirror exercise would work easily.

The art would need simplification for some, but worked well for the more able.

### *How can the practical activities be adapted to work better for this class?*

Using a small mirror, a greasy finger print, and breath would work in a classroom.

### *Are there improvements in the way the practical activities are working?*

Painting the way light works through a prism is a new skill that requires subtle colour mixing, and observation, as well as precision with the brush.

### *How relevant are these activities to the overall lesson sequence?*

All activities are relevant, and are relevant to each other in some respects.

### *To What extent do these activities differ from previous ones?*

Painting develops more precision in painting skill

Science looks at reflection

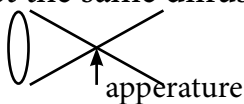
Literature links subject to the philosophical.

## Day 12 - Descriptive Sampling Data

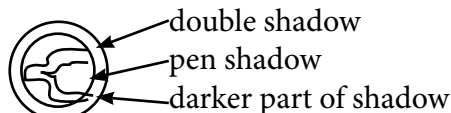
### Science Experiment Day 12 (1st 15 mins)



Looking through the aperture of a light shone on a wall I can see the diffused edges around the circle - the top diffused area looks grayish yellow and the bottom grayish blue. Putting a pen and small items in the light I get the same diffused lines around objects it shows the light two sources of light on two edges;



I was particularly interested in the darker shadow in the diffused area, e.g.

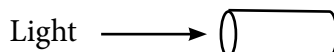


### Science Experiment Day 12 (2nd 15 mins)



Using rolled up card I shone the light through this. Reflection had no double shadow as if light had become straightened.

Shadows were only slightly doubled, but same if tube is taken away and object held at same distance.



### Science Experiment Day 12 (3rd 15 mins)

Working with two red candles the candles gave out a reddish glow - but the flames a yellow light. Holding a pen over paper I got a green and a purple shadow, the purple being much stronger - Ist shadow blue from yellow light - red hue makes blue purple but green shadow repelled the red and resulted from the red hue - when candles were down to one - I had a much darker black purple shadow. Do the colours change in relation to one another?

### Science Experiment Day 12 (4th 15 mins)

Using a torch light to get a third shadow I got green purple and red shadows. I was particularly interested in this and want to explore more and understand why I need to revisit earlier chapter where Goethe goes over this.

But seeing where shadows overlap I can see that they get darker and that if the two lights are brought close together that this stimulates the same effect as a large light with light coming from both sides or all extremes. Also shadow gets more diffused as it is lifted up further from the ground.

### Art Work, Day 12 (1st 15 mins)

Studying the crystal I noticed that there was white reflected areas and inside by some of these there were refracted pink, blue, yellow green tones, in other places there was a gray which urrred towards blue in some places, yellow in others, and pink in others. There was a reality between the mixing of coloured matter and coloured light which I was observing as I painted.

### Art Work, Day 12 (2nd 15 mins)

Blending in the different shades of the crystal I am filled with delight as the shape starts to glow and hold in the light, but in the final stages I am frustrated that the lightest areas can not be made lighter as pure white paint cannot meet the luminosity of pure reflected light.

### Art Work, Day 12 (3rd 15 mins)

Finishing the reflection in the vase of the crystal I am able to study how the reflected rays get weaker as they are reflected, in this case they are also coloured as the bronze gives them a yellowish tone.

### Art Work, Day 12 (4th 15 mins)

I realised that by looking at the close up details of the work I stopped seeing the whole picture. Now standing back and looking at this I realised that the shadow of the table cloth over the front of the table needed to be substantially darker and the window needed a sheen so that the image through it looked more distant. Now I had more perspective in the work. I also wondered how this is a metaphor for how we perceive thoughts in general and began thinking of the philosophical aspects of this notion.



## Literature choice, Day 12

Just as in the prism a white ray of light is split up into seven darker shades of colour, so the divine personality or Ego has been broken into countless susceptible substances. As seven darker shades melt together in one clear pencil of light, out of the union of all these substances a divine being would issue. The existing form of natures' fabric is the optical glass, and all the activities of spirits are only an endless play of colours of that simple divine ray. If it pleased Omnipotence someday to break up this prism, the barrier between it and the world would fall down, all spirits would be absorbed in one infinite spirit, all accords would flow together in one common harmony, all streams would find their end in the ocean.

*Schillers' Philosophical Letters - Theosophy of Julius*

Friedrich Schiller

## Literature choice, Day 12 comment

This literature connects the philosophy of existence and reality and its relationship with matter to the way light as a pure source is divided into colours through a crystal casting a spectrum. **This connects well** to many of the science experiments, but particularly to the painting I was working involved intense focus on the painting of a crystal. In the painting I became aware of far more refractions than the spectrum, as pale nuances of colour filled the planes of the crystal, with different colours on different planes. The division of colour is more varied than first thought, as this can be said to be the same with the variety and multitude of spirits created out of one source.

## Action Research, Day 12

### *How well do the practical activities work?*

The science experiments were straight forward and can easily be reproduced in a class. The artwork is a good extension for more able students, but would be difficult for students with less ability.

**I decided on completing the artwork that Write's "An Experiment on a Bird in an Air Pump" would be too difficult for the students to paint, and too time consuming.** Instead a focus on the lighting of the different peoples faces could be observed but not painted.

The next painting will be based on 'The Swing' But this will be simplified into a flower scene simply using the same colours and composition.

### *How can the practical activities be adapted to work better for this class?*

Some students could copy an enlarged close up of the crystal and side of vase, taken from my painting. They could work with chalk pastels instead of paint.

### *Are there improvements in the way the practical activities are working?*

Painting the way light works through a prism is a new skill that requires subtle colour mixing, and observation, as well as precision with the brush. But for students who can not manage this working with chalk pastel and observing and replicating the refraction and reflections in a crystal would involve advanced observation skills.



*How relevant are these activities to the overall lesson sequence?*

All activities are relevant, and are relevant to each other in some respects.

*To What extent do these activities differ from previous ones?*

Painting develops more precision in painting and observation skill

Science looks at reflection and refraction.

Literature links subject to the philosophical aspects of reality and existence.

## Day 13 - Descriptive Sampling Data

### Science Experiment Day 13 (1st 15 mins)

(420) Doing this activity I didn't initially have success but when looking for time at the window edge and then turning my head towards a white wall I saw lightness where the window frame had been with blue gray above and yellow gray below. This seemed a better way of demonstrating the experiment than looking slightly up or down. But **I wondered** if the purpose of doing this was to demonstrate double shadows.

### Science Experiment Day 13 (2nd 15 mins)

Re-reading the experiments **I see the point** of the exercise was to see what happens when the head tilts forward or back. I tried this, with some success. I also looked at upward bars. What I experienced was the changes in lightness and darkness rather than colour, but this **triggered the thought** that the world of images around us are always a **subjective experience**, as even the tilt of the head changes the colour around us. A painting is this frozen in time. A photograph can not record these subtle subjective changes, and **perhaps is one reason** why it can never look as alive as a painting, where such subjective experiences can be caught and accentuated. Likewise a painting can not capture the degree of contrast actual darkness and lightness really has, and can only give a muted impression of it.

### Science Experiment Day 13 (3rd 15 mins)

I found it less successful working with the epoptical experiments. 1st working with flat glass plates I could only get a sheen. Putting oil between them and using a lens I could get small sparkles. I then moved to using glass bowls and lids, and I was able to get some coloured shapes with the spectrum moving from one shape to another, as I pressed the shapes together and moved them around. **I would have liked to photograph or paint this**, but the slightest movement changed the shapes.

### Science Experiment Day 13 (4th 15 mins)

The best result was in bubbles, using a potato masher. I picked up dish-washing liquid and blew bubbles - the full spectrum could easily be seen moving in these. And a full intense spectrum could be seen in the holes of the potato masher here the colours move as I tilt it. **These look spectacular!**

### Art Work, Day 13 (1st 15 mins)

Sketching in and painting the background I found myself **thinking** about the double shadows that appear behind objects and realised why a background is not a flat colour but changes as it appears to come close to an object in front of it.

### Art Work, Day 13 (2nd 15 mins)

At this stage **I felt aggravation** that the red is not in balance as the dark green leaves are still to be painted. But I will complete the flower first as it is wilting in reality.

### Art Work, Day 13 (3rd 15 mins)

What seemed dark initially then seemed light by comparison. **I realised** that part of being able to paint is the ability to separate what shades I see, and select different tones as I go along - now it is time to see the dark tones in the flower.

### Art Work, Day 13 (4th 15 mins)

Bringing in the darker shades the flower now takes 3 dimensional shape. **It now needs** the darker tones around it to hold it in place. Set against its opposite colour which to colour perspective moves to the distance, this experience has an extreme distance to foreground colour perspective.

### Literature choice, Day 13

The sun, it is said, is only a type of the essential absolute good - the corporeal light bears a precisely similar relation to the spiritual, and when contemplated from the spiritual region is nothing but darkness, in which every mind gropes about which is enchanted by the charm of the terrestrial sun, and, without endeavoring to rise higher, lingers among the material things illuminated by it.

*Schillers' Philosophical Letters - Theosophy of Julius*  
Friedrich Schiller

### Literature choice, Day 13 comment

In the painting I was **considering and observing** how colour and tone changes according to what is by it, and what we are focusing our attention on. This literature demonstrates the same thing in relation to observations from the worldly in contrast with observations from the spiritual. While the suns light is the brightest from a worldly perspective, from a spiritual perspective it is dull, and it is in this dullness, or darkness that human thought gropes about, unless it attempts to move beyond the material.

## Action Research, Day 13

### *How well do the practical activities work?*

The science experiment worked with the bubbles **but not so well with the glass layers**. This would need to be well tested with objects before given to a class.

Painting the background first worked well as when the flower is painted a good experience of colour perspective is achieved, and finding colour balance is better experienced.

### *How can the practical activities be adapted to work better for this class?*

Tight fitting clear glass bowls may work better in the science experiment.

The painting is simplified for all levels of ability.

### *Are there improvements in the way the practical activities are working?*

Colour perspective is clearly a strong factor in this paintings composition, and easier to experience. **Science experiment would work better with previous painting.**

### *How relevant are these activities to the overall lesson sequence?*

Painting and literature are relevant, **science experiment is better related to previous painting and literature.**

### *To What extent do these activities differ from previous ones?*

Painting develops compositional skills and colour perspective. Science looks at reflection and refraction thus continuing on from previous experiments. Literature links subject to the philosophical aspects of human materialistic thought from a worldly perspective, and spiritual thought from a spiritual perspective.

## Day 14 - Descriptive Sampling Data

### Science Experiment Day 14 (1st 15 mins)

(No 14) Looking at the two disks one black, one white, on backgrounds of the opposite colour, the black did seem smaller than the white at first glance. However if I look at the white disk looking at the black peripherally, I found that the black tended to grow bigger than the white with blue below and yellow rings appearing around it thus making it seem larger. Goethe says that white excites the eye and black reposes it. But in these experiments it would tend to depend on whether we look at the disk, or the background.

### Science Experiment Day 14 (2nd 15 mins)

Looking at a light then looking at a white wall I saw dark where the light was, and light around it. I then looked at a light for a lengthy time and closed my eyes the image of the light stayed as a light for a long time the inner was white yellow, surrounded by magenta, purple, blue, green. As time went on the shape grew smaller in size, the white turned more yellow and the blue and magenta being most prominent grew lighter until an inner magenta and outer blue/green appeared, this then turned into a dark purple with a bright blue rim. Finally a black/purple dot. The **experience is quite rewarding** and **reminds me** of a meditative experience.

### Science Experiment Day 14 (3rd 15 mins)

Selecting a gray area on the wall I held up a black pencil and focused on it for a time. The area around it appeared lighter. Then I removed the pencil and the area where the pencil had been now appeared light. I did the same with the white corner of a book. This gained a dark rim around the edge, and when I removed the book, I saw a dark area on the wall where the book had been. This reminded me of painting objects against a skyline, how in modern paintings they have a hard edge, and yet there is something stark and unnatural about this. Where as painting in the dark or light halos gives a more comfortable feeling to the artwork.

### Science Experiment Day 14 (4th 15 mins)

Experimenting with gray on white and black it appears to be too different shades of gray, but take away the two back grounds and the gray appears the same. This exercise reminds me of many optical illusions I have seen. I can think of many I can use in class such as the checker board with a shadow, where the black in the light, is the same as the white in the shadow. This also relates to the painting experience I had with the shadows of the flower where the darker tones had to keep being made darker than I first thought they needed to be.

### Art Work, Day 14 (1st 15 mins)

Already the flower is not alone, it's leaves now float just behind it and they appear to be coming towards us from the distance. Just like the swing the orange/white swings out towards us, but in the original picture the black/green beneath seems to pull it back.

### Art Work, Day 14 (2nd 15 mins)

Giving the leaves yellow and white highlights gives them a depth and they now look more dense and appear to fill up more space. Interesting here to consider where the light shines through a leaf (yellow) and where it reflects (white)

### Art Work, Day 14 (3rd 15 mins)

There still needs to be more darkness around the lower part of the flower in order to settle it. The original picture has yellow ochre which would help to settle the orange which contrasts too much at present.

### Art Work, Day 14 (4th 15 mins)

Now putting in the dark shadows under and around the flower and leaves the flower settles into place. I add touches of ochre where the white was and this helps the orange to belong with the leaves. The strokes connect the form, the ochre the colour.

Now the painting is finished it looks much bigger than the previous one, though they are the same size. The tightness of form and dark background of the previous picture pulls the eye inwards. But the expansive nature of the plant only partially seen and the hazy blue/turquoise creating distance in this picture gives an expansive quality. This is similar to the black/white disk experiments done earlier, but with the added dimension of colour and the forms chosen as subjects.

## Literature choice, Day 14

Hail holy light, offspring of Heav'n first born,  
Or of th' Eternal Co-eternal beam  
May I express thee unblam'd? Since God is light,  
And never but in unapproached light  
Dwelt from Eternite, dwelt then in thee,  
Bright effluence of bright essence increate.

*Paradise Lost - Book 2*

John Milton

## Literature choice, Day 14 comment



This literature is an ode to the glory of light, in this respect it reflects the **wondrous experiences** I had with the optical illusions **in both** the painting and the experiments.

## Action Research, Day 14

### *How well do the practical activities work?*

The science experiments work well and are easily suitable for a class.

The painting is simplified enough for all levels, and the colour experience is easily gained from it.

### *How can the practical activities be adapted to work better for this class?*

Light reflection and illumination can be pointed out by bringing in an actual plant and putting it in the sun.

### *Are there improvements in the way the practical activities are working?*

Working with colour contrast is a good next step in the painting process. Working with David's 'Oath of the Horatii' is more related to composition and less about light, and since I am running out of science experiments I decided it would be good to move on to Turner's painting next.

### *How relevant are these activities to the overall lesson sequence?*

Colour experiments in science are very relevant with colour composition used in the painting.

### *To What extent do these activities differ from previous ones?*

Painting develops understanding of colour depth and composition

Science looks at optical illusions in relation to colour

Literature links subject to wonder of light.

## Day15 - Descriptive Sampling Data

### Science Experiment Day 15 (1st 15 mins)

Testing out after vision of coloured paper on black and white backgrounds I found looking at the bright colour on black - then removing the black so that the after image was on the white was most effective and more reliable than seeing the after image with eyes closed as I usually do. Also good to look at how light and dark tones of colours effect the after image.

### Science Experiment Day 15 (2nd 15 mins)

Doing the experiments again, the surrounding area is noted to change into a light version of the coloured squares opposite. This is best shown with white paper on a coloured wall so that the mass influences the small. **This is very relevant** to painting where slight tints can be given to white areas to accentuate the effect and this seems to harmonize the painting, and give it a quality that photography can't achieve.

### Science Experiment Day 15 (3rd 15 mins)

Wearing coloured glasses the room looks red or green etc and takes on a **mood** as well as a tone. If red glasses are taken off, the room then takes on a green glaze and **mood**.

### Science Experiment Day 15 (4th 15 mins)

Looking at grass in a sunset the red glow brings out the colour green and harmonizes other colours. This can also be experienced looking through the coloured glasses. This **relates to** using coloured glazes in art to harmonize a painting and here we get to experience the effects of different colours. Orange makes everything **feel warm and comfortable**, where as **Green is refreshing**, if it is a yellow green, but a blue green makes you **feel unnerved**. This **reminds me** of the Bauhaus experiments using purple light on food - causing no one to eat the food until a yellow light was shone on it.

### Art Work, Day 15 (1st 15 mins)

First step in painting the Turner painting was to **decide** what medium to use. **I decided** on watercolor. Next was to **decide** where the dark areas were as I would need to paint around the light allowing the lightness of the paper to shine through. This meant the **I needed** to sketch out the horizon line and the shapes of the ships. As I was doing this **I thought** about the underlaying tone being yellow. This is likened to wearing the yellow glasses in the science experiment. But the blue had no yellow in it, so I needed to start by covering the whole picture with either blue or yellow, overlapping where the brow/black areas would later be. In other areas they did not meet for this causes green, and there was not green in these areas in the original painting.

### Art Work, Day 15 (2nd 15 mins)

Painting the faint yellow and blue undertones I get a sense of a dim after image. This acts as a kind of sketching in, as there is room for mistakes here. Even so, my attention is on the measurement of distance between shapes and proportions rather than colour. **Knowledge** of the hazy afterimages around shapes in reality **gives me a sense of** it is OK if things aren't quite right as there is movement in reality too.



### Art Work, Day 15 (3rd 15 mins)

Bringing the blue stronger now **I wonder if** I am bringing it in too dark. Sometimes I work with what is right at the time but it changes to too light when I bring the stronger tones in. Can I see the blue for what it really is? This reminds me of **deeper perceptions**, do I see them for what they really are? Or do I only see how I have perceived the colour at that time? Are my perceptions always coloured by emotions? Can I ever, even with the most stringent scientific methodology, see things with out colouring them with my own schema? And is it accurate to do so, or is perception meant to be biased, for without bias it is not really human?

### Art Work, Day 15 (4th 15 mins)

Bringing the blue in a darker tone more delicately around the forms I **get the feeling** that this is the right gesture for blue, and it **feels very satisfying**. No other colour could work in this way to the same effect. It is like an artistic idea that starts in the periphery and slowly moves in and gives shape to something that can develop within.

### Literature choice, Day 15

All come forth to the cheerful light  
How lively, see! the multitude sallies,  
Scattering through gardens and fields remote,  
While over the river, that broadly dallies,  
Dances so many a festive boat;  
And overladen, nigh to sinking,  
The last full wherry takes the stream.  
Yonder afar, from the hill-paths blinking  
Their clothes are colours that softly gleam.

*Faust - said by Faust to Wagner*  
Johann Goethe

### Literature choice, Day 15 comment

This literature **connects** the subject of boats lit up in the reflections from light and water, in both the painting and the literature. It fills one with the same **joyful experience** one gets from looking at the painting. A **sense of wonder, reverence and joy**.

### Action Research, Day 15

*How well do the practical activities work?*

The science experiments would work well in a class.

The painting style at this stage leaves lots of room for mistakes, and so is suitable for all students' ability.

*How can the practical activities be adapted to work better for this class?*

Students could be given an option to use chalk pastels instead of water colour if they find watercolour too difficult.

*Are there improvements in the way the practical activities are working?*

Moving on to watercolour is a progressive next step in learning to handle mediums, and develop painting skill. Practical science experiments relate well to Turners new achievements in painting.

*How relevant are these activities to the overall lesson sequence?*

Science and painting activities worked well together. Subject matter of literature worked well with subject matter of painting. Lightness of Goethe's poetry matched lightness and delicacy of the newer approaches to colour in painting, and subtlety of scientific understanding.

*To What extent do these activities differ from previous ones?*

Watercolour experience advances artistic skill and develops subtlety of colour nuances.

Science reflects this in study of colour afterimages

Literature reflects not only subject imagery, but lightness of rhythm and delicacy of words.

## **Day 16 - Descriptive Sampling Data**

### **Science Experiment Day 16 (1st 15 mins)**

Trying out different combinations of coloured light with candle light I was able to get a dull shadow with a faint opposite colour and a dark shadow the colour of the light in every case.

### **Science Experiment Day 16 (2nd 15 mins)**

Using red, yellow and white lights I got red green and purple shadows. Usually one of the three shadows disappeared. But generally I get two of the coloured light, one darker than the other, and one of its opposite of a medium tone.

### **Science Experiment Day 16 (3rd 15 mins)**

Placing a box in the light, by using two candles and a magenta light I was able to get all three shadows to overlap. This created a shadow that went from green/black to light green to magenta to light magenta. Moving an object over the white area I was able to get a shadow that changed from light magenta to dark green as I moved it round the page, and took it further from the magenta light, and closer to the candle which produced the green shadow.



### Science Experiment Day 16 (4th 15 mins)

Using a candle, a magenta light and a blue light I was able to get just a blue and orange shadow. The magenta light was too weak to create a shadow, but when the orange shadow crossed another blue one it turned purple.

I could play with these shadows for hours and can imagine them being really stimulating for the students. The effects **remind me** very much of artworks done in the modern era. Such colours and tones really **create mood, and emotion**.

### Art Work, Day 16 (1st 15 mins)

Putting on a pale layer of red the paint starts to **take on new life**. I **need to** put a new layer of red slightly darker now before I can put the details of the ship in. It is amazing how just these 3 colours can create such a range of different hues and this reminds me very much of how the spectrum created by the prism expands when tilted and creates more hues. The red still needs strengthening to do this to more effect, but can't be put in too strong in the first instance or it will overtake the painting. It needs just enough for the yellow to grow into orange with strengthened red in just a few places. The balance required is delicate.

### Art Work, Day 16 (2nd 15 mins)

Now the red is starting to dominate and yellow needs to be brought back in to create orange, thus **allowing the yellow to breathe out into the red and shine**. This **reminds me** of the light of advanced thinking which is so easily dominated by material problems and pragmatic concerns. The **thinking** needs help to shine through. But the paint needs to dry before I do this so I turn my attention now to balancing the light, with dark and begin the darker stronger colours of the ships and shadows.

### Art Work, Day 16 (3rd 15 mins)

Putting in the dark details is **immensely satisfying**. It is as if I have created the form out of the substance around it like the drawing in of an inspirational thought. Now I get to fill in the details of what sits inside, like bringing a creative idea to birth.

### Art Work, Day 16 (4th 15 mins)

A certain **liveliness and personality** is now working its way into the painting, as if this is now able to enter the form. It **reminds me** of how after coming up with the **overarching concept** of what I intend for a new main-lesson, now I begin to look at the details and in bringing it into the classroom I start shaping the content around the individuals in the class. At this stage I bring in an array of colours, orange, brown, prussian blue, crimson - I deviate from the simple pure blue red and yellow. Just like the colours that separate out of the prism, and create more colours when mixed, and still more when shadows are created - so with the introduction of darkness comes specific shades and colours - from spirit to personality.

## Literature choice, Day 16

When his [God] celestial rays begin to shine within us, then we see in the true light; then there is no truth to which we do not instantaneously assent, as we admit, without any process of reasoning, the splendor of the sun, the moment we behold his rising beams.

*Spiritual Progress - Chapter IV II*

François Fenélon

## Literature choice, Day 16 comment

Working on the Turner painting, the **experience of working with light** filled transparent colour gives a lightness and a sense of delicacy towards the use of colour. This is **a transcendent feeling**, and is **matched with** the feeling alluded to in the literature, where something which is true, is experienced like the splendor of the sun as it rises.

## Action Research, Day 16

### *How well do the practical activities work?*

The science experiments work well. The painting experiment also works well.

### *How can the practical activities be adapted to work better for this class?*

I have mentioned that **some students with lesser ability could do the artwork in chalk pastels**. However I have noticed that new experiences gained by overlapping transparent colours stimulate deeper thinking, and this would not be achieved with pastels.

### *Are there improvements in the way the practical activities are working?*

Working with transparency is a very useful next step in painting development.

Working with coloured shadows is also a great next step, however this could come earlier.

### *How relevant are these activities to the overall lesson sequence?*

Using two lights yellow and white in the painting, and observing how these reflect in the water, make this activity closely relate to the science experiments using coloured lights.

### *To What extent do these activities differ from previous ones?*

Using transparency to create nuances of colour

Use of coloured shadows was also done earlier, but not is so much detail

Literature stimulates higher thinking in relation to science and art activities. Set 1



Has doing an activity stimulated me to think about light and colour?

This occurs 100/144 total logs

This occurs 90/128 descriptive sampling logs

This occurs 45/64 science logs

This occurs 45/64 art logs

This occurs 10/16 literature logs

This occurs x times on:

Day 1 - 5  
Day 2 - 5  
Day 3 - 7  
Day 4 - 3  
Day 5 - 4  
Day 6 - 6  
Day 7 - 8  
Day 8 - 5  
Day 9 - 9  
Day 10 - 6  
Day 11 - 8  
Day 12 - 8  
Day 13 - 8  
Day 14 - 7  
Day 15 - 5  
Day 16 - 6



Has doing an activity stimulated me to feel experiences in relation to light and colour?

This occurs 48/144 total logs

This occurs 41/128 descriptive sampling logs

This occurs 16/64 science logs

This occurs 25/64 art logs

This occurs 7/16 literature logs

This occurs x times on:

Day 1 - 0  
Day 2 - 3  
Day 3 - 1  
Day 4 - 4  
Day 5 - 2  
Day 6 - 4  
Day 7 - 3  
Day 8 - 4  
Day 9 - 1  
Day 10 - 3  
Day 11 - 1  
Day 12 - 1  
Day 13 - 5  
Day 14 - 5  
Day 15 - 5  
Day 16 - 6



Has thinking about the subject inspired me to do the activity better?

This occurs 14/144 total logs

This occurs 14/128 descriptive sampling logs

This occurs 12/64 science logs

This occurs 2/64 art logs

This occurs 0/16 literature logs

This occurs x times on:

Day 1 - 1  
Day 2 - 0  
Day 3 - 0  
Day 4 - 0  
Day 5 - 0  
Day 6 - 2  
Day 7 - 2  
Day 8 - 0  
Day 9 - 1  
Day 10 - 1  
Day 11 - 3  
Day 12 - 3  
Day 13 - 0  
Day 14 - 1  
Day 15 - 0  
Day 16 - 0



Has having feelings about the subject inspired me to do the activity better?

This occurs 7/144 total logs

This occurs 7/128 descriptive sampling logs

This occurs 2/64 science logs

This occurs 5/64 art logs

This occurs 0/16 literature logs

This occurs x times on:

Day 1 - 0  
Day 2 - 1  
Day 3 - 1  
Day 4 - 0  
Day 5 - 0  
Day 6 - 1  
Day 7 - 1  
Day 8 - 0  
Day 9 - 0  
Day 10 - 0  
Day 11 - 0  
Day 12 - 1  
Day 13 - 0  
Day 14 - 1  
Day 15 - 0  
Day 16 - 1



Have I crossed the subject domains of Art, Science and Religion, through the process of thinking, feeling or willing?

This occurs 63/144 total logs

This occurs 50/128 descriptive sampling logs

This occurs 16/64 science logs

This occurs 34/64 art logs

This occurs 13/16 literature logs

This occurs x times on:

Day 1 - 6  
Day 2 - 1  
Day 3 - 4  
Day 4 - 3  
Day 5 - 5  
Day 6 - 4  
Day 7 - 5  
Day 8 - 3  
Day 9 - 3  
Day 10 - 5  
Day 11 - 2  
Day 12 - 4  
Day 13 - 4  
Day 14 - 5  
Day 15 - 4  
Day 16 - 5



Has the crossing of subject domains led me to heightened thinking, such as the consideration of ethics, aesthetics or epistemology?

This occurs 22/144 total logs

This occurs 13/128 descriptive sampling logs

This occurs 5/64 science logs

This occurs 8/64 art logs

This occurs 9/16 literature logs

This occurs x times on:

Day 1 - 1  
Day 2 - 1  
Day 3 - 0  
Day 4 - 1  
Day 5 - 2  
Day 6 - 2  
Day 7 - 1  
Day 8 - 1  
Day 9 - 1  
Day 10 - 1  
Day 11 - 1  
Day 12 - 2  
Day 13 - 1  
Day 14 - 2  
Day 15 - 3  
Day 16 - 2



Has the crossing of subject domains imbued me with deeper creative experiences, such as experiencing a flow of feelings, a metamorphosis of sense impressions, experiencing a sense of knowing through feeling?

This occurs 21/144 total logs

This occurs 14/128 descriptive sampling logs

This occurs 3/64 science logs

This occurs 11/64 art logs

This occurs 7/16 literature logs

This occurs x times on:

Day 1 - 1  
 Day 2 - 2  
 Day 3 - 1  
 Day 4 - 1  
 Day 5 - 2  
 Day 6 - 2  
 Day 7 - 0  
 Day 8 - 0  
 Day 9 - 1  
 Day 10 - 0  
 Day 11 - 0  
 Day 12 - 0  
 Day 13 - 1  
 Day 14 - 2  
 Day 15 - 4  
 Day 16 - 4



Has the crossing of subject domains inspired me to set my will to the accomplishment of new virtuous goals, such as those that relate to truth, goodness and beauty?

This occurs 3/144 total logs

This occurs 3/128 descriptive sampling logs

This occurs 3/64 science logs

This occurs 0/64 art logs

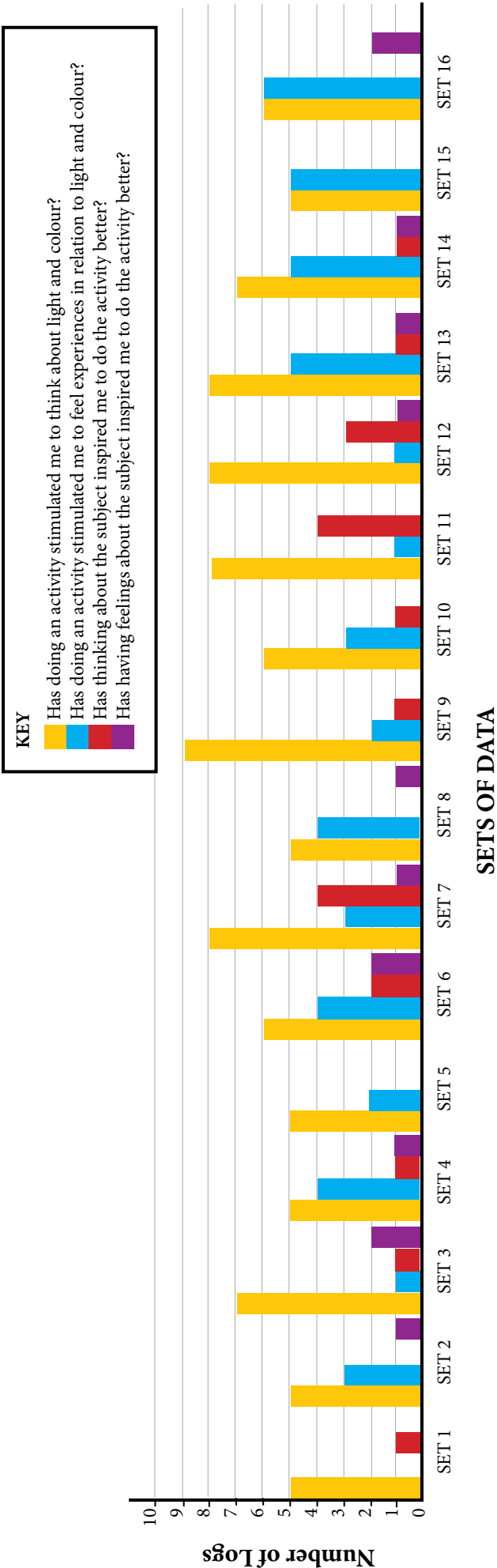
This occurs 3/16 literature logs

This occurs x times on:

Day 1 - 0  
 Day 2 - 0  
 Day 3 - 0  
 Day 4 - 0  
 Day 5 - 0  
 Day 6 - 1  
 Day 7 - 1  
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 Day 12 - 0  
 Day 13 - 0  
 Day 14 - 0  
 Day 15 - 0  
 Day 16 - 0

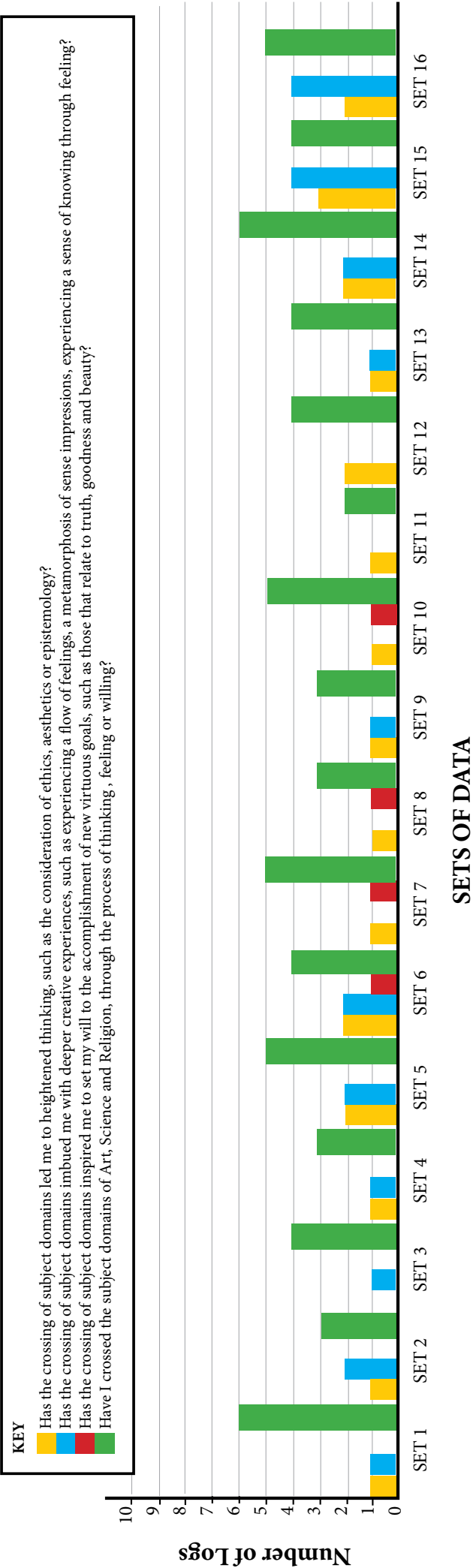
## Relatability of Content between Domains of Art, Science and Religious Literature

	Literature and Art relate generically	Art and Science relate generically	Science and Literature relate generically	Literature and Art relate specifically	Art and Science relate specifically	Science and Literature relate specifically	Total number of yes answers for set
<b>Set 1</b>	Yes	No	No	Yes	No	No	2
<b>Set 2</b>	Yes	Yes	Yes	No	Yes	No	4
<b>Set 3</b>	Yes	Yes	Yes	Yes	No	No	4
<b>Set 4</b>	Yes	No	No	Yes	No	No	2
<b>Set 5</b>	Yes	Yes	Yes	No	Yes	No	4
<b>Set 6</b>	Yes	Yes	Yes	No	Yes	No	4
<b>Set 7</b>	Yes	No	Yes	Yes	No	No	3
<b>Set 8</b>	No	No	No	No	No	No	0
<b>Set 9</b>	Yes	No	Yes	Yes	No	Yes	4
<b>Set 10</b>	Yes	Yes	Yes	No	Yes	No	4
<b>Set 11</b>	Yes	Yes	Yes	No	No	No	3
<b>Set 12</b>	Yes	Yes	Yes	No	Yes	No	4
<b>Set 13</b>	Yes	Yes	Yes	Yes	No	No	4
<b>Set 14</b>	Yes	Yes	Yes	No	Yes	No	4
<b>Set 15</b>	Yes	Yes	Yes	Yes	Yes	Yes	6
<b>Set 16</b>	Yes	Yes	Yes	Yes	Yes	Yes	6

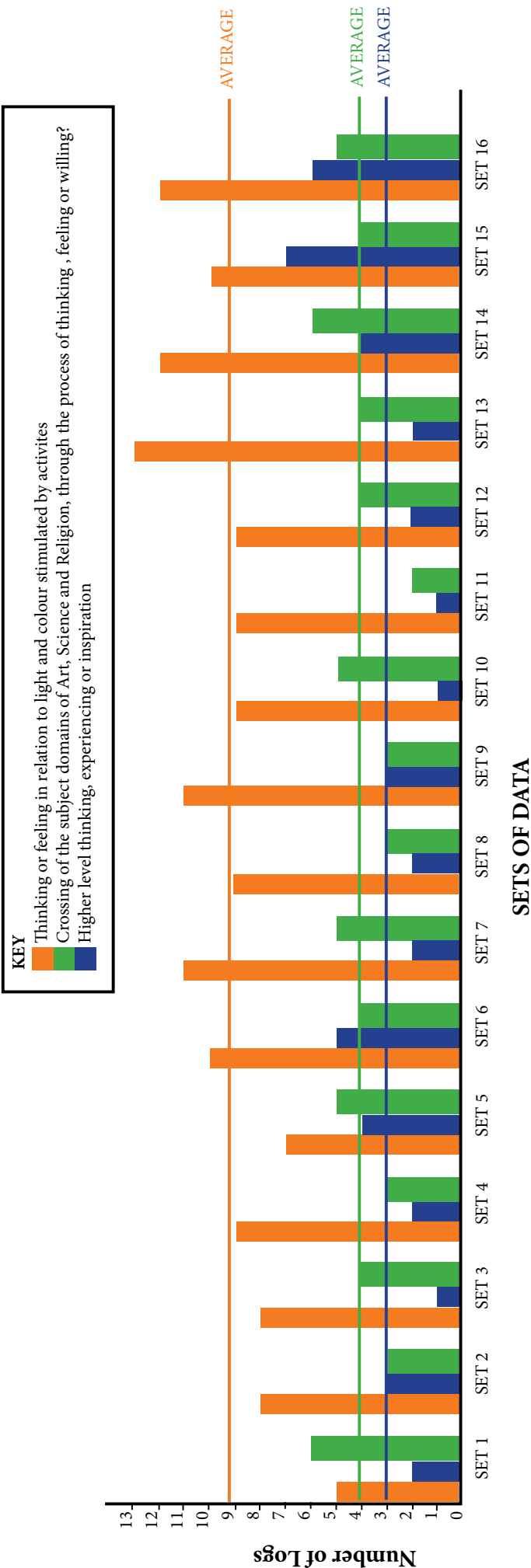


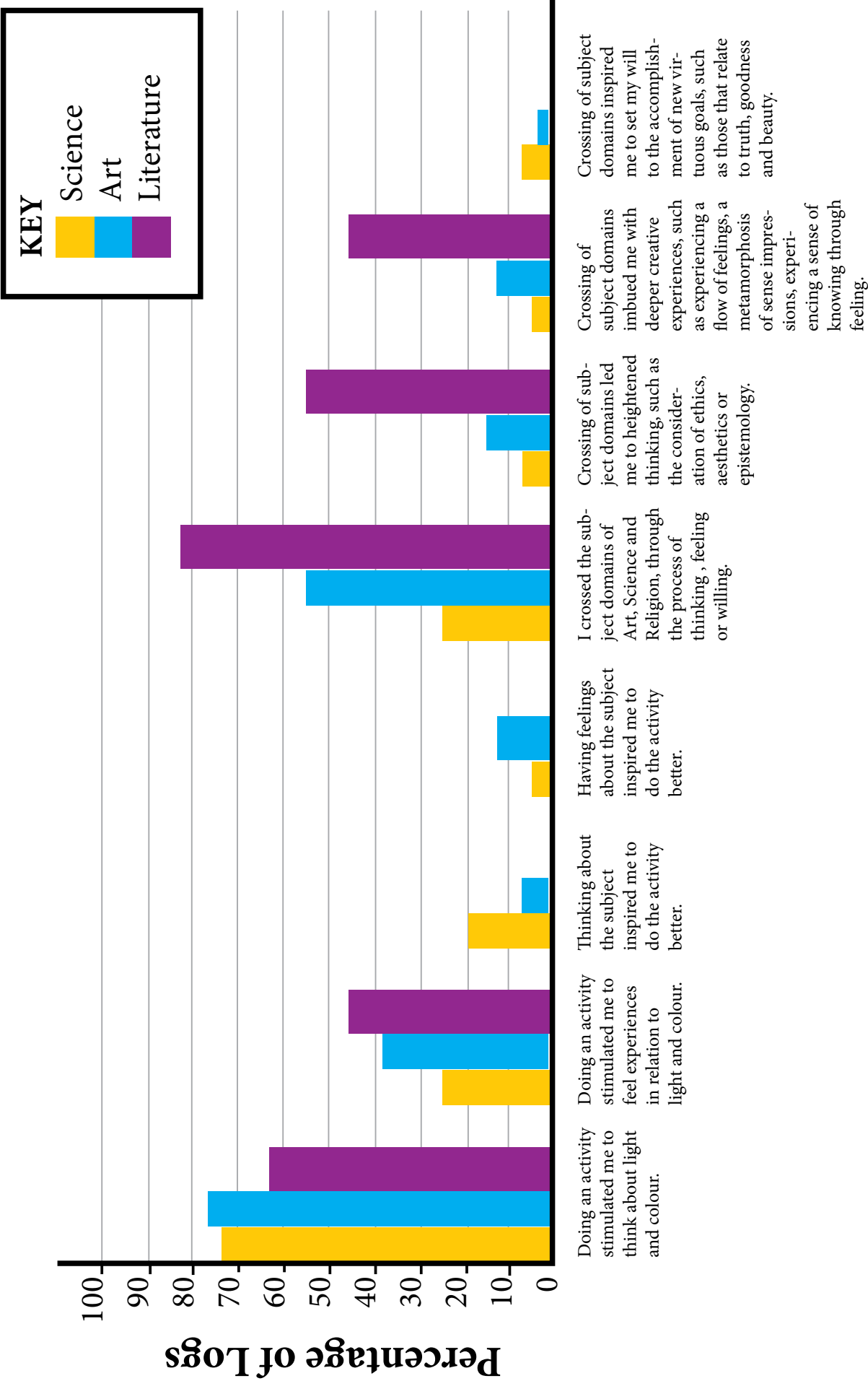
Graph B

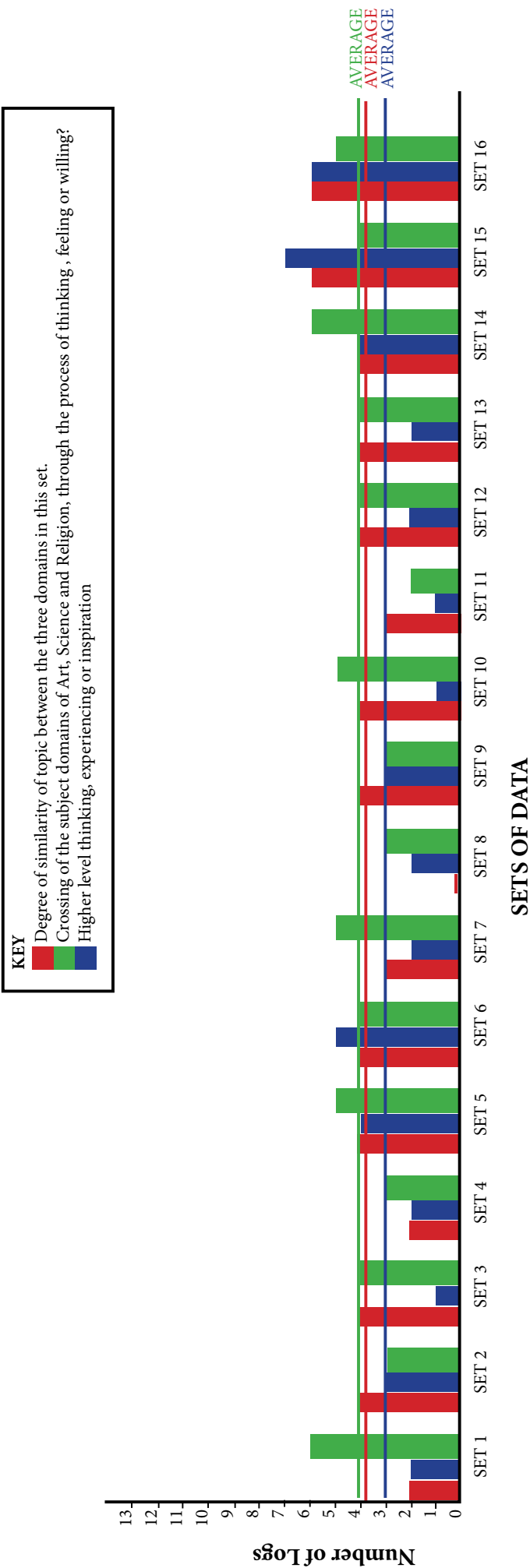
Graph B











## **Appendix E:**

**The finished Teachers' Resource Book follows this page. It will also be provided as a separate book.**

# Light and Colour



An Educational Resource for the  
Unification of Art, Science and Spirituality

By Josephine Erskine



# Light and Colour

An Educational Resource for the  
Unification of Art, Science and Spirituality.



By Josephine Erskine

# Introduction

The Renaissance period brought about an age of discovery, when older traditions began to be questioned. The world was no longer thought to be flat, new countries were being discovered, and questions about the workings of stars and planets began to be explored. The old religious doctrines became involved in a struggle with scientific ideas about the natural world. But the struggle maintained its balance. Art rose to its heights blossoming forth out of both science and religion.

The process that was begun in the Renaissance grew out in multiple directions and flowered during the Baroque period. Art historian Gottfried Richter (1985, p. 203), describes this as a time when “the individual faculties of the human soul divide”, as art, science and religion move further apart. Science looks more and more towards the natural world and forgets the concept of a supreme being. Religion loses connection with the world around it. And art forgets its roots in the sacred sense of awe and focuses more on the application of new ideas.

Yet for all the chaos this created, it also stimulated great developments. Scientific studies achieved leaps in human understanding. Philosophy of the Spirit sought to clarify religious notions, and human individuality became a subject of study. While art, no longer confined to maintaining balance, ran from extreme to extreme picking up new subjects, and new ways to create. The breaking up of this triad caused an explosive chaos that led to a massive expansion in overall human development. But the end of the well-rounded ‘Renaissance Man’, resulted in the development of the one-sided modern individual, where specialization is the norm.

It may have been necessary for the three sections of the triad to be separated. This freed them from restrictions enabling great advancements to be made. However looking at these retrospectively, it is possible for us to put back the pieces and rediscover these great advancements from an overarching holistic perspective. Such an immense task is too much to comprehend completely, but we can focus on a topic and examine how the different sections of the triad have affected it, following this with an examination of how the different sections have influenced each other. There are many ways to do this, but as an



art teacher, the subject that jumps out before me as a very clear place to begin is that of light and colour.

This book is intended to be a teaching resource, looking at Art, Religion and Science in regards to the subject of light and colour. It covers the time from the post-renaissance to the Romantics. It will look at art and at philosophical and spiritual writings from this time, and cover the scientific experiments of Newton and Goethe on the subject.

This resource can be used by art, science or humanities teachers, and follows the development of consciousness on the topic of light, dark and colour. However after conducting research on the effects on learning whilst combining these three domains, I found that only one subject, that of art, needed to follow a chronological order. Literature and science could be reshuffled chronologically to connect with the artist activities provided they maintained a logical order to their specialised processes.

I made the decision to order the activities around the art, rather than the science or literature, partly because I am an art teacher, and will use the contents of this book in my own teaching, and partly because there is a steady building up of physical skills in the art lessons, whereas the science and literature are based more on the exploration of knowledge, with a particular order being less of a priority.

The time frame I have selected to work from ties in with learning themes appropriate for Class 10 in the Waldorf curriculum. It can of course be adapted to suit any teaching or curriculum needs. More importantly it should be viewed as one way of uniting the domains of art, science and spirituality around a particular theme, with the aim of being an exemplar for this approach, rather than a model to be copied.



# Baroque Art

## Light and Dark

“Beauty no longer means harmony but strength.” This was a description used by Gottfried Richter (1982/1985, p. 205), to describe the change from Renaissance to Baroque. He further refined this definition by explaining that; “Harmony is a state of being, something resting quietly within itself, balanced and clarified. Strength is a state of becoming, something pressing out beyond itself, limitless and in constant ferment.”

In Caravaggio's work we see an example of this strength with his use of simple monumentality, and his avoidance of the use of masses of figures and explosive scenes. With his work we see the changeover from Renaissance to Baroque, where strength comes to the fore, but an uncomplicated balance is still able to be achieved. However this balance is not harmonic, it appears as a dramatic balance between extremes and gives the impression of something about to erupt into action.

He simplified his pictures down to just a few characters, which were compositionally placed to show the narrative in a powerful yet simplistic way. Here we can see that the gesture and facial expressions tell a clear story. But even more powerful is the dramatic use of lighting which leads the eye to the climax as Thomas puts his finger into the wounds of Christ. Like the great thinkers from Caravaggio's time, Thomas needed proof before he would believe that Christ had truly risen from death. Yet the story doesn't end there, it leaves us with a sense of expectation. The composition of the painting may be simplistic, but the feelings we are left with are explosive.

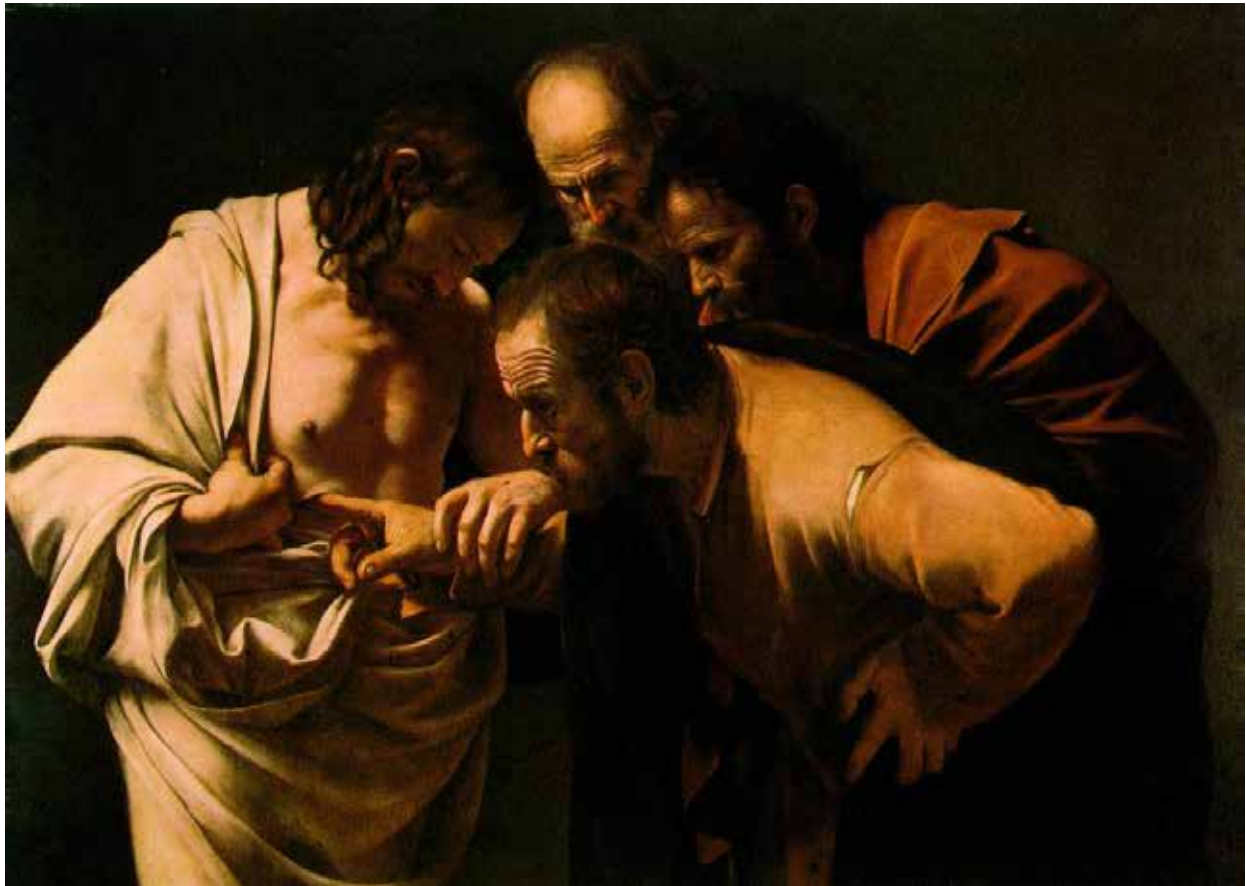


Figure 1.  
*The Incredulity of St Thomas*  
Michelangelo Merisi da Caravaggio | 601 -2  
107 x 146 cm  
Oil on canvas  
Sanssouci, Potsdam

Caravaggio's figures stand out directly from the darkness, losing any faint background tones that might give a hint of what might lay there. His carefully selected and positioned subjects are undisturbed, and glow before us like a monument. The vectors created from the characters gaze and the use of highly contrasted light lead us straight to the climax. As the art historian Anna Krausse (2005, p. 34-35), described: "The light appears almost as an active participant in the events. It generates spatiality, it makes the colours glow, dynamizes the composition, gives the bodies plasticity, and gives the paintings as a whole an almost mystical spirituality."

## Science

# Rays of Light

What is this light that glows out of the darkness so superbly throughout the Baroque period? When Sir Isaac Newton (1669/2010), set out to explain the properties of light he began with some simple definitions. The first was what he referred to as a 'ray' of light. To Newton this was the term he used to define the smallest part of light. He did not think of light as made up of a mass of particles, but rather as something that moved in a straight line from a luminous source until it is intercepted.

We can observe how rays of light work by setting up the following exercise.

### ACTIVITY A

1. Take a box with an open end, and make a small hole in the center of the side facing the opening.
2. Darken the room.
3. Put a lit torch in the box so that the light shines through the hole in the box.
4. Blow white chalk dust or a fine powder, into the air through which the beam of light is passing (Goethe, 1810/1970).
5. We can now observe how the beam widens and weakens as it moves further from its source.
6. Move the torch up close to the hole in the box, and then pull it back again, observing how the beam widens and narrows as we do this.

The light casts out multiple rays from the full width of the light source, and each ray passes through the small opening and continues in a straight line. The multiple rays of straight lines are each on a slightly different angle from one another, dependent on where they begin in the torch and where they pass through the hole in the box. As we move

the torch back and forth we change the angle of these rays, and thus the beam of light coming through the hole widens or narrows.

As the beam widens it appears to lose intensity. Newton (1669/2010), thought that the rays were further apart the more the beam widens, and thus the beam appeared to loose intensity.

We understand rays further if we observe the way shadows are created from objects.

### ACTIVITY B

1. Put an object on a flat surface, in front of a beam of light, as set up in Activity A. The more sculpturally intricate this object is the better.
2. Shine a narrow beam on the object. Observe the highly contrasted details of the sculptural object. If the light is able to pass past the object, you should be able to see a sharply defined shadow.
3. Shine a wide beam on the object. Observe how details are now softer and less defined, the contrast is not as sharp, and the shadow has a diffused edge.
4. Open a curtain, or turn on the main lighting, and then observe how the lighting of the object, still exposed to the same beam as before, changes as does it's shadow.

When the light beam was narrow in a dark room, its rays were running close to parallel with only a slight angle between each. These hit the object as a relatively straight beam and the area the beam does not hit remains in shadow. This is straightforward and easy to understand. However it becomes more complex when we shine a wide beam over the object. Now we have to contend with each individual ray shining from a far more noticeable angle. We can no longer see a clear definition be-

tween lit and shadowed areas on the object because the minute shadow projected from one light ray is different from that of another, and thus gray areas are created. However it is still clear from which general direction the light is coming.

When we open a curtain, or turn on the main light then the effect of light on the object changes entirely. If the light from the beam is still stronger than the outer light then we will still see the shadows in the same place, but they will be far

less distinct with a greater range of grays. Light rays are now coming from multiple directions, each forming it's own minute lit area and shadow. What we see as light areas is where there are generally more rays hitting the object, and what we see as dark are where there are fewer rays hitting the object. But in reality there are now light rays hitting the object from all directions, and only the base, which can not be seen, and the occasional deep crevice are still able to avoid being lit.

## Art

### The Incredulity of St Thomas

Graphite pencil on cartridge paper

Caravaggio's painting of 'The Incredulity of St Thomas' (p.5) uses a narrow beam of light shining on characters in a very dark setting. We can learn more about how this works by drawing it.

Start this activity by deciding how much of it to draw. I would suggest drawing just Thomas and Jesus on which these examples are based. For students who find this too difficult the area around Thomas's pointing finger could be blown up and drawn.

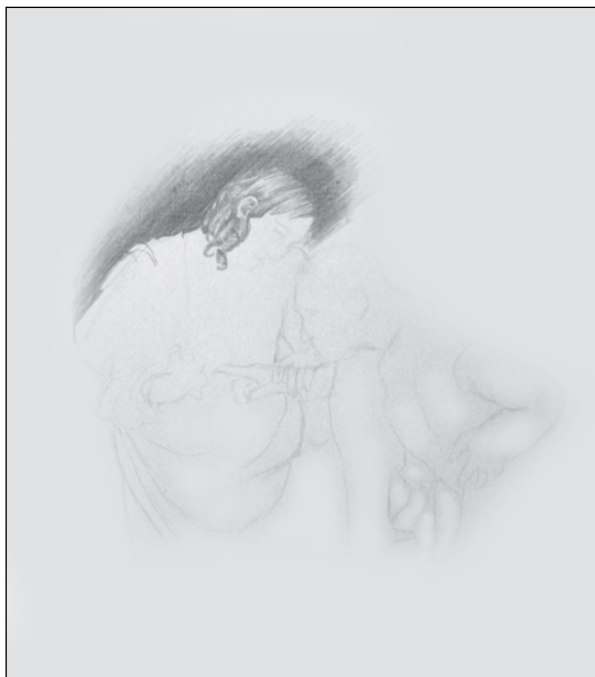
**1. Begin by loosely mapping in where the characters are on the page. Keep your lines loose and soft, barely touching the paper. They should be light enough that you can go over them without needing to rub anything out.**

This is what is called an under drawing, and it does not need to be accurate, it is just there to give you a guideline for the rest of your work. Avoid using an eraser at this stage, or you will start to weaken the paper, and disturb the texture of it.

**2. Pick out an easy area to observe and draw, making sure that you pick a place that includes the densest tones that will be used in the drawing. Shade in the darkest tones in this area next.**







This will give you a gauge on which to measure the degree of darkness you will need for the rest of the picture. It is very easy to begin too light, and then when you reach the end you will need to go over the whole picture darkening it. You can avoid this by making sure you work darkly enough right from the beginning.

### 3. Slowly build up the details spreading out from where you started.

Always work on simplified areas when you are trying to focus, and leave faces, hands and intricate areas until you are fully focused on the picture. It is important not to talk when you are working on these detailed areas as they require your full attention.

As you work on the details you need to be constantly visually measuring what you are doing. The width of the eye in comparison with the width of the nose; the distance from nose to eye in comparison with the distance from eye to ear; and ear to back of the head. You need to fully focus on making multiple visual measurements per second,



the more you make the more accurate your drawing will be.

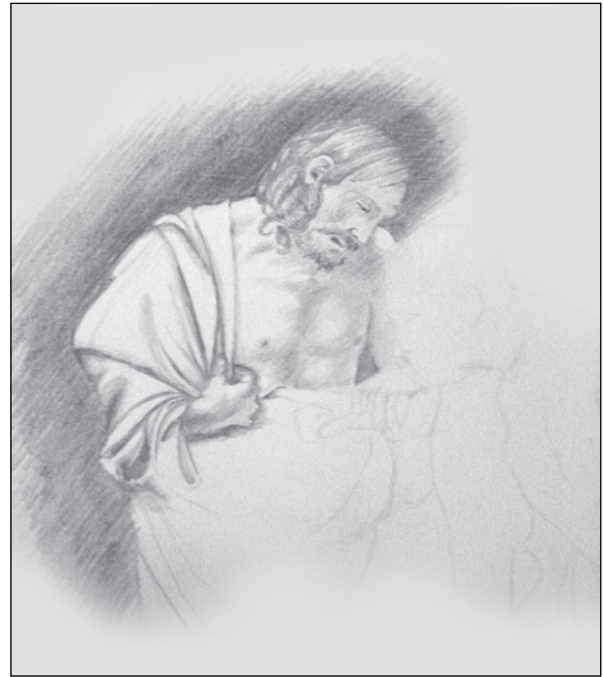
The other thing you must focus on is the light and the shadow, and how this determines the form. You should not simply copy the shading from the original picture, but you need to imagine how light falls on a shape as you are shading it.

## Spiritual Literature

When the mind is enlightened by  
Divine truth, and duly impressed  
with a sense of guilt, it cannot fail  
anxiously to inquire, how can a man  
be just with God.

*Justification*  
Dr. Charles Hodge, 1878  
(Hodge, 1878, part. I. parag. I)

This is particularly evident when you are drawing human forms, as the slightest error in the shading and the human appears to develop a deformity. One cheek can protrude more than another or the body can become irregular. The only way to avoid this is to imagine you are sculpting the form out of clay, and imagining how the light hits the raised forms, and casts shadows over the others. You need to imagine where some areas block the light over others, and you need to keep your shadows at the same rate of diffusion and elongation as they all come from the same light source.



## Science

### Reflection and Reflexivity

The bright areas of our drawing are reflected light. Newton (1669/2010), defined reflection as the turning back of rays of light. He defined reflexivity of rays of light as being lights different disposition to being reflected, explaining that where a reflection is more intense and bright the reflexivity of the light is greater. If we use the same set up as in the first science activity (p.6) then we can observe what Newton meant by these terms.

#### ACTIVITY A

1. Take a box with an open end and make a small hole in the center of the side facing the opening.
2. Darken the room.
3. Put a lit torch in the box so that the light shines through the hole in the box.

4. Pull the torch back to make a narrow beam of light, and place an object, such as unpolished wood, matt card, or unglazed pottery, in the beam of light.
5. We can now observe how the beam is stopped and sent back as reflected light. In comparison with the darkness of the shadow the lit areas of the object appear to glow.
6. Place a piece of paper in front of the lit area to catch the reflected rays. Make sure that the paper does not block the beam of light. Then we will see a slight change to the brightness of the paper as it catches the reflection and sends it back again.
7. Slide the torch forward to make the beam wider and the reflected light now appears to glow less.
8. Repeat the instruction in 6. You will find that the paper barely changes in brightness.

The narrow beams of light reflect better than wide beams. Once turned back, the light is able to reflect off another surface, but this is barely noticeable with the wide light reflecting off a matt surface.

#### ACTIVITY B

1. If we now repeat the same exercise with a shiny object such as polished metal, we see that the object shines much brighter in both forms of light, and reflects back on to the paper much more powerfully. Yet the reflection from the narrow beam is still much more defined.
2. We will also see that the colour of the metal is re-reflected back from the paper.

This is particularly noticeable with a coloured metal such as bronze.

#### ACTIVITY C

1. Try the exercise again with a mirror. Observe how the re-reflection is not only brighter but that the re-reflection will actually produce a coloured image on the paper.

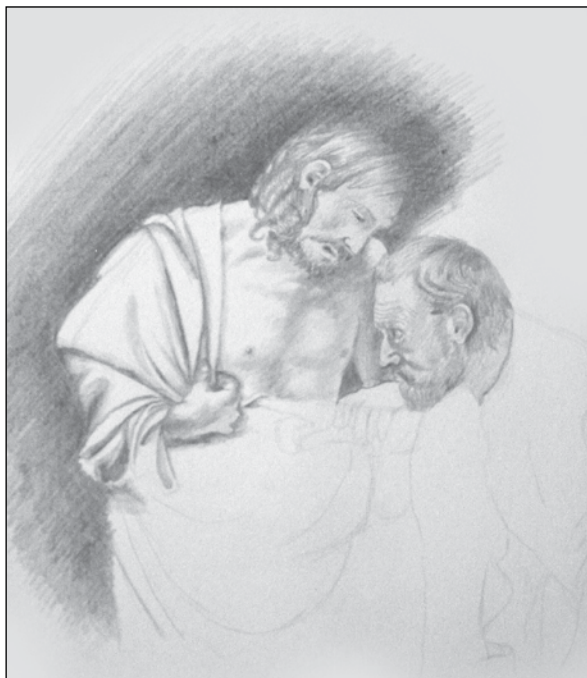
Light reflected back from shiny objects is more reflexive than that reflected from matt objects. Shiny objects are more reflective, and the more reflective the object the more its ability to project light or an image.

## Art

### The Incredulity of St Thomas

Graphite pencil on cartridge paper

Consider the way the light reflects when you return again to your drawing. In this picture the obvious place to continue is with Thomas' face,



but this requires much focus and attention. Resist going straight to work on areas of intense detail but warm yourself up to this first.

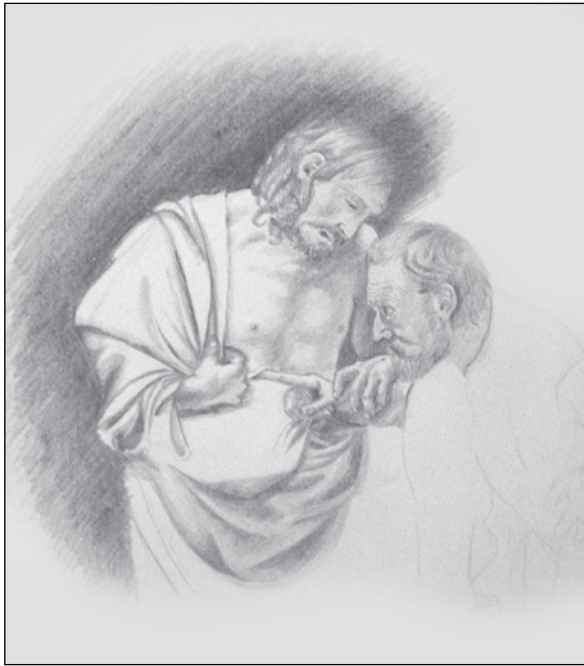
1. Start by going over the areas you have already rendered, smoothing out the tone and evening out the shadows.

You will notice that when you look at a picture again after a break, that any irregularities tend to jump out. Smooth over these, as you tune yourself back into the work.

2. Then start rendering Thomas's face.

Remember to constantly measure distances and proportions by eye, imagine the form sculpturally, and imagine how the light would fall on it.





### 3. Move on to the hands.

These are intricately detailed so keep focused. Remember the golden ratio in the divisions between the fingers, and consider how each finger casts its own shadow on both itself and on the others.

### 4 Begin work on the folds of the garments. Start with Christ's garment and look for one recognizable fold among the cascade of them.

## Spiritual Literature

No Light, but rather darkness  
visible

Serv'd only to discover sights of  
woe,

Regions of sorrow, doleful shades,  
where peace

And rest can never dwell, hope never  
comes

That comes to all; but torture  
without end.

*Paradise Lost*  
John Milton 1667  
(Milton, 1667, p. 4)

Focus only on this one fold, look at where it is in proportion to the overall picture. Look at how it transforms into smaller folds. Now look at where the light reflects back; where shadows are cast; at where the shadows are darker; and where they dissipate into grays. Then concentrating on just this fold, or set of folds, work intently on just this area of the drawing.

## Science

### Refraction and Refrangibility

Newton (1669/2010), defined refraction, as the bending of rays of light as they move through a translucent body. Refrangibility of rays of light was according to Newton, lights disposition to be re-

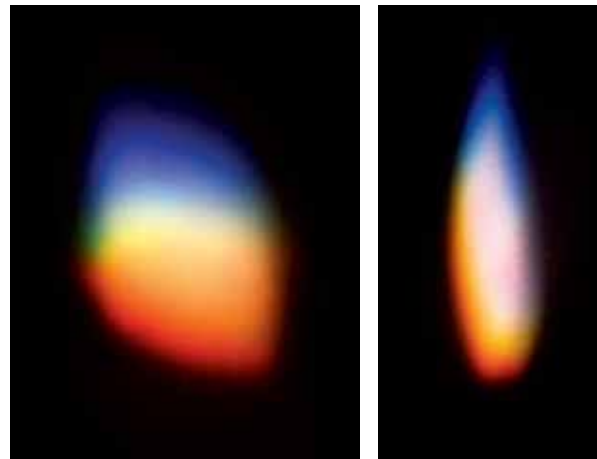
fracted from one transparent medium to another. The more a ray can refract inside one single medium, the greater the refrangibility. We can see how a beam of light refracts in the following activity.



### ACTIVITY A

1. Take a box with an open end, and make a small hole in the center of the side facing the opening.
2. Darken the room.
3. Put a lit torch in the box so that the light shines through the hole in the box.
4. Fill a clear glass rectangular or square container with water and add just enough milk to make the water cloudy, but not opaque.
5. Shine a narrow beam of light through the water from the front, and look through the side to see how the beam bends as it reaches the translucent medium of the water.
6. Widen the beam, and it will be hard to distinguish how it bends.

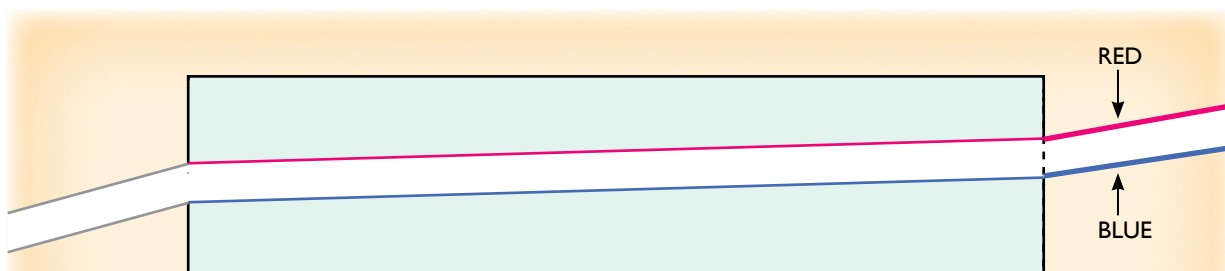
The more tightly the rays travel straight together, the more we are able to see the refrangibility of the beam of light. It refracts or bends as it moves from one translucent body to another, and continues to travel as a beam of light until it either reflects off the opposite side of the container or refracts again as it travels out the other side. But Newton (1669/2010), found that not all light rays refract in the same way. Some refract more from the original passage of light, and these become blue light.



Those that refract the least become red. A whole spectrum of colours can appear between these extremes. Therefore Newton concluded that blue rays are the most refrangible while red rays are the least with other colours' refrangibilities dependent on their position in the spectrum.

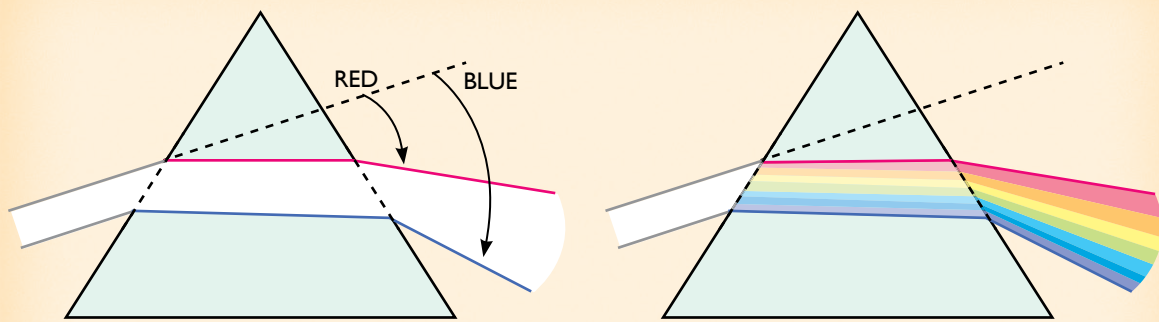
### ACTIVITY B

7. Replace the container of water with a glass prism and cast the light through the prism opposite a white wall, or large flat white area. Adjust the angle of the prism until a spectrum is cast on the flat white area.
8. Blow powdered chalk into the air between the prism and the wall and you will see how the colours are projected separately right from the prism.



When white light passes through a square or rectangular translucent object, there is no angle of deviation between the entry beam and exit beam. However, there is a thin fringe of red and of violet light on the outer edges of the beam emerging from the prism.

Illustration adapted by the author (Refraction and the ray model of light, n.d.)



Blue light refracts more than red light due to the difference in wavelength. This causes blue light to deviate from its original path by a greater angle than the red light.

Illustration adapted by the author (Refraction and the ray model of light, n.d.)

## Art

### The Incredulity of St Thomas

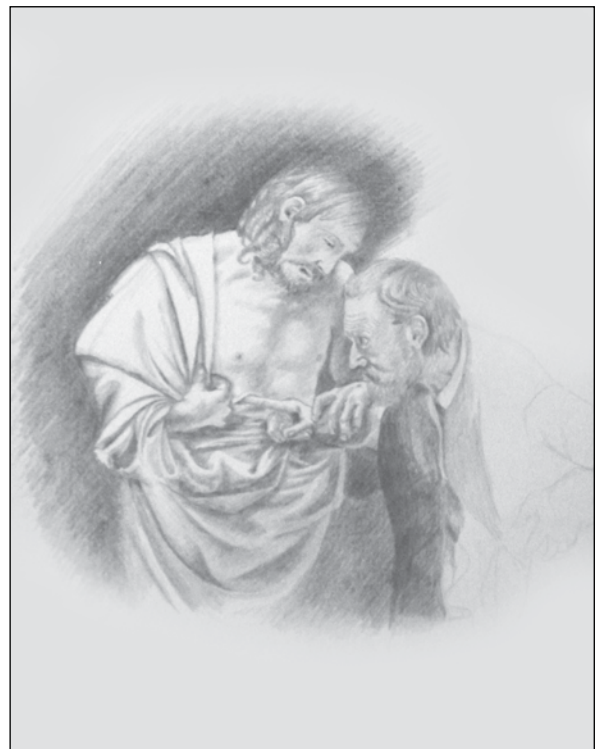
Graphite pencil on cartridge paper

Goethe (1810/1970), concluded that colour is born out of the meeting between light and darkness. Think about this as you convert the colour master into your black and white drawing.

Remember that when first looking at a picture after you have had a break from it, any imbalances will jump out and be noticeable.

**1. Adjust anything you notice that is not quite right.**

Note that problems are often not where you first think them to be. You can see this when shading and drawing the folds of the garments. You might for example try to get the shape of the shaded area right when in fact all that is needed is a touch of darker shading in one specific area.

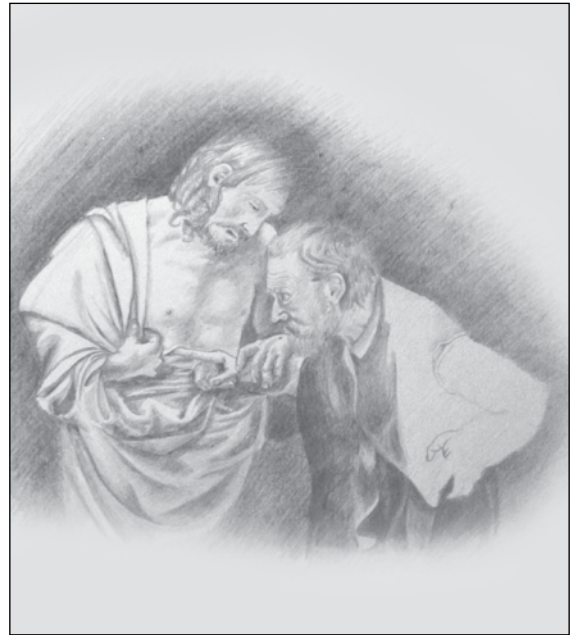


## 2. Continue working on the garments

Take special care with the tonal range in the folds of the garments, there are spots of the darkest tones hidden in small areas among the folds, and these create depth.

3. Add contrast to the clothing by creating wider areas of dark tones in completely shadowed areas, such as on Thomas's clothing.

4. Finish off by completing the shading in the background.



## Spiritual Literature

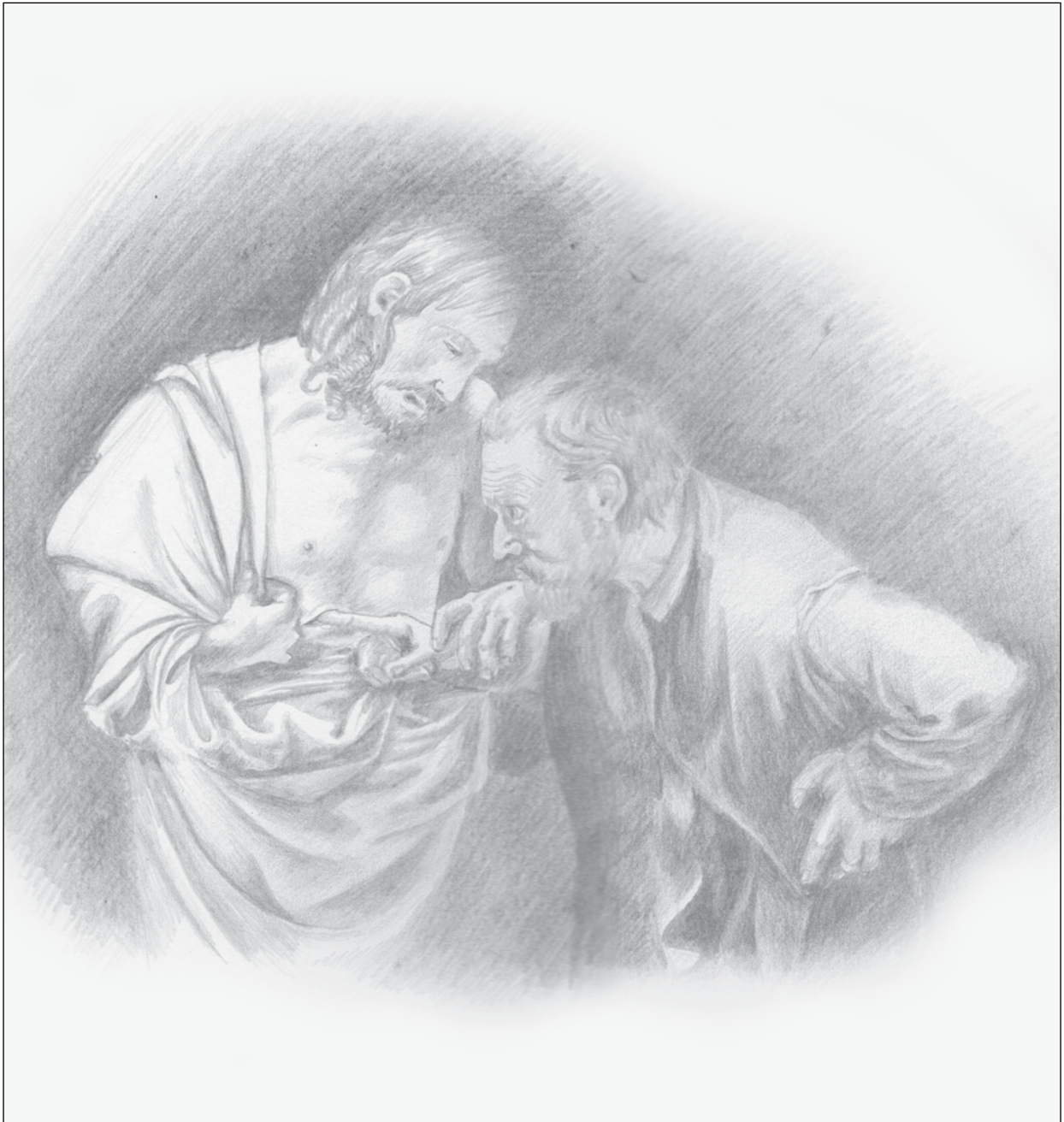
Thomas, called the Twin, who was one of the Twelve, was not with them when Jesus came. When the disciples said, "We have seen the Lord", he answered, "Unless I see the holes that the nails made in his hands and can put my finger into the holes they made, and unless I can put my hand into his side, I refuse to believe". Eight days later the disciples were in the house again and Thomas was with them. The doors were closed, but Jesus came in and stood among them. "Peace be with you" he said. Then he spoke to Thomas, "Put your finger here; look, here are my hands. Give me your hand; put it into my side. Doubt no longer but believe." Thomas replied, "My Lord and my God!" Jesus said to him:

"You believe because you can see me.

Happy are those who have not seen and yet believe."

*The Jerusalem Bible*  
John 20:24-29  
(Jones, 1974, p. 151)





Author's pencil drawing of Caravaggio's  
*The Incredulity of St Thomas*

# Baroque Art

## Glowing Colour

Baroque art displays a pushing out in all directions and as it does so it creates a new more expansive sense of space. This space is not confined to linear perspective as was the case up to the mid Renaissance. But the use of colour perspective developed in the high Renaissance, which coupled with the advances made in the chemistry of paint making, led to whole new depths of colour. Gottfried Richter verges on the poetic with this description:

Suddenly the earth has colours that play over softly into one another, colours that blossom in the light and burn with an inner fire. Everything is aglow, the leaves of the trees, blossoms and fruits, the clouds in the sky, human skin, fabrics and various kinds of wood. The whole infinite variety of earthly phenomena lights up, and the eye is soon drunk from the floods of colour. For all the colours seem secretly suffused by a golden glow that breaks loose every so often and pours out in a powerful flood. It is as though the gold background that had dissolved in the Renaissance as the earth ascended, is suddenly present again, but now it is within the earth, blossoming forth out of every facet of it. (Richter, 1982/1985, p. 214)

Nicolas Poussin in his painting of 'Diana and Endymion' contrasted the glowing quality of golden yellow with the depth and forming quality of blue in all its varieties of tone. The background sky has a soft blue contrasting with a powerful golden yellow. Yellow is a soft dissipating colour, but when surrounded with blue it becomes dynamic, echoing the gesture of Apollo and his powerful steed pulled fiery chariot. The golden glow reflects down on the scene below, which contrasts with the bright sky through its application of rich, darker and heavier tones. The curtain of dark indigo blue, the deepest of all colours, contrasts with the strongest use of gold, making Apollo stand out. The intensive vibrant ultramarine of the curtain pulling figure's garment, positioned in the golden section of the scene, creates a dynamic balance with the golden glow over the rest of the picture. This could not have been achieved with the tempera paintings of the Renaissance, but the advancements made in oil paint quality, and the use of canvas makes this level of depth possible.

At the height of the power of the French Court, when the 'Sun King' was lavishing funds on the Arts in general and in the creation of the Palace of Versailles in particular, the French artist Poussin was also at his height. However he avoided the King's desire for him to work at Versailles. Poussin disapproved of monumental history painting and the glorification of the king. He instead studied in Italy and worked out of what was later called 'Baroque classicism',



Figure 2.  
***Diana and Endymion***  
 Nicolas Poussin c. 1630  
 Oil on canvas  
 The Detroit Institute of Arts, Detroit, USA.

where themes from classical times were used to portray contemporary notions (Krausse, 2005. p35-36). In this picture Endymion a mortal man known for his beauty, is on his knees before the goddess Selene. Selene, also known for her beauty, was the moon goddess and the twin sister of the sun god Apollo. The drawn curtain represents night. The sleeping puti represent the enchantment put on Endymion by Zeus, whereupon he could retain his beauty eternally, but only if he remained asleep. The moon goddess visited him nightly and their love for each other was great, but the mortal beauty needed to remain asleep to godly beauty, though they were able to produce many children (Littleton, 2005).

Just as Caravaggio's painting opened an array of questions of what it meant in relation to the thinking of the time, so this painting of Poussin opens an array of questions about the relationship between mortal and supreme beauty. Even with all the advances made in painting during this time, was Poussin saying that all human appreciation for aesthetics was only a vague dream in comparison with supreme beauty? Or was he, by showing Endymion on his knees rather than asleep, saying that mankind could now see and adore the aesthetics of the supreme? Why are the sleeping puti and shepherd gathered around the curtain of night, while the awake Endymion and Selene are in the full light of the sun?



# Dioptical Colours

Goethe the scientist and the poet saw in the coloured spectrum something of supreme beauty. A man of his times, he wanted to understand it. Like Newton he also explored light as it moves through transparent mediums, but he referred to colours as being 'dioptrical' when a colorless transparent (or semi-transparent) medium is necessary to produce them. (Goethe, 1810/1970, p. 59)

He describes the sun as a pure white light made of 'phosphorus burning in oxygen', but this white he says appears yellow to us because the earth's atmosphere is a semi-translucent medium. (Goethe, 1810/1970, p. 61) He explained that if we view the sun at sun rise or sunset, the angle of our vision passes through a thicker blanket of the earth's atmosphere. And as we do this the colour of the sun takes on an orange, and then a ruby red hue.

On the other hand, he concluded that, if the earth's atmosphere has light shining on it, and the darkness of space is viewed behind it, then this darkness is seen as blue which becomes deeper and more violet the more the atmosphere thins, and lighter and more towards white as the atmosphere thickens.

He suggested the following activities to illustrate this theory (Goethe, 1810/1970, p. 64-68).

### ACTIVITY A

1. Fill a clear container with water (preferably rectangular or square).
2. Put in just enough milk so that the water is slightly clouded, but still transparent.
3. Use a semi-darkened room for best effect.
4. Shine a strong white light through one side of the container, and look at it from the

opposite side. Observe the colour which should appear yellow.

5. Shine the light on the water so that it is illuminated, place black card behind the container, and observe it from the opposite side. It should appear blue.
6. Put in more milk, and repeat 4 and 5 above. The yellow should become more orange, and the blue lighter.

### ACTIVITY B

1. Light a candle in a semi-darkened room
2. Put white card behind the candle and view it from the opposite side. Observe how no blue can be seen in the flame.
3. Put black card behind the flame, and viewing the flame from the opposite side, observe the blue now in the flame.

### ACTIVITY C

1. Light incense to create smoke in a semi-darkened room
2. Shine a light on white card behind the smoke. Observe how from the front the colour of the smoke appears yellow.
3. Illuminate the smoke, and put black card behind it. It should appear blue from the front.

### ACTIVITY D

1. Place a piece of transparent paper on a window where the sun is shining brightly through it.
2. Then place another at an angle and continue to do so. Observe where the papers overlap, they should appear yellow. The more they overlap the more the yellow tends towards orange/red.

## Art

# Diana and Endymion

Coloured pencil and oil pastel  
on cartridge paper.

Blue and yellow are the main colour theme you will explore in this next work based on Poussin's 'Diana and Endymion'. Work from the original picture for the details of the colours and forms, but use the simplified version I have created for the composition. See pages 17 and 23.

1. Use a gold or brown coloured pencil to loosely and lightly sketch in the main shapes.

Remember to avoid using an eraser and to keep your line work loose and light so that this will not be seen when you work over it to correct details.

2. Now begin with the yellow areas, and try to keep your strokes on an angle from top right to bottom left. Use lemon yellow for the lightest areas and golden yellow for the majority of the yellow area. Where the gold is intensified work very hard with the gold, and bring out the darker shape forming of Apollo and his chariot by using orange. Make sure that some very light areas of gently applied lemon yellow are left for the highlights on Apollo.
3. Then use a yellowish-brown to dull down and give shape to the clouds, whilst remaining aware that the lightest yellow part of these clouds are where Apollo's light would be reflecting off them.

## Spiritual Literature

All night the dreadless Angel unpursu'd  
Through Heav'n's wide Champaign held his way,  
till Morn,  
Wak't by the circling Hours, with rosie hand  
Unbarr'd the gates of Light. There is a Cave  
Within the Mount of God, fast by his Throne,  
Where light and darkness in perpetual round  
Lodge and dislodge by turns, which makes  
through Heav'n  
Grateful vicissitude like Day and Night;  
Light issues forth, and at the other dore  
Obsequious darkness enters, till her hour  
To veile the Heav'n, though darkness there  
might well  
Seem twilight here; and now went forth the Morn  
Such as in highest Heav'n, arrayd in Gold  
Empyrean, from before her vanisht Night  
Shot through with orient Beams: when all the  
Plain  
Coverd with thick embatteld Squadrons bright,  
Chariots and flaming Armes, and fierie Steeds  
Reflecting blaze on blaze, first met his view.

*Paradise Lost*  
John Milton 1667  
(Milton, 1667, p. 161)



Observe the feeling you get when you work with yellow on a white page. Note how it feels to intensify the yellow with orange and brown, and how it feels when this starts to give it form.

#### 4. Bring in the medium blue.

Pay attention to how this changes the effect of the yellow and consider what these changes are.



## Science

### Refrangibility of coloured light

As shown earlier on pages 11-13, Newton (2010, p. 122-124), thought that coloured light was caused by its degree of refrangibility. He also concluded through the following experiments, that this could not be changed by reflecting or further refracting the coloured light.

#### ACTIVITY A

1. As done in earlier activities, darken a room, create a narrow beam of light, and shine this through a prism so as to cast a spectrum on a flat white area.
2. Take a piece of card with a small hole no larger than 5mm diameter, and hold it up between the prism and the projection so that only one of the spectrum's colours is able to pass through the hole.
3. The single coloured light should now be reflecting back from where it has been projected. Hold a piece of white card up to the coloured projection, in such a way that it does not block the projection, and observe what colour is reflected back on to the white card.

You will see that blue light reflects blue light back, green light reflects green light back and so on.

#### ACTIVITY C

4. Repeat the exercise with a mirror and observe what happens.

Even with the reflective qualities of a mirror coloured light remains the same colour when it is reflected. It neither reverts back to white light nor does it reflect back the complimentary colour.

#### ACTIVITY C

1. Put another prism in the beam of single coloured light, and refract this coloured light on to the white flat area.
2. Try the same activity with other isolated colours.

Whichever colour of light you use, it remains the same colour when refracted through another prism.

Newton claimed these activities proved his theory that the colour of the light was determined by the refrangibility of the rays. Neither reflection nor any attempt of further refraction could change the refrangibility of the coloured rays, which remain a constant property of the light.

## Spiritual Literature

A thing of beauty is a joy for ever:  
Its loveliness increases; it will never  
Pass into nothingness; but still will keep  
A bower quiet for us, and a sleep  
Full of sweet dreams, and health, and quiet breathing.  
Therefore, on every morrow, are we wreathing  
A flowery band to bind us to the earth,  
Spite of despondence, of the inhuman dearth  
Of noble natures, of the gloomy days,  
Of all the unhealthy and o'er-darkened ways  
Made for our searching: yes, in spite of all,  
Some shape of beauty moves away the pall  
From our dark spirits. Such the sun, the moon,  
Trees old and young, sprouting a shady boon  
For simple sheep; and such are daffodils  
With the green world they live in; and clear rills  
That for themselves a cooling covert make  
'Gainst the hot season; the mid forest brake,  
Rich with a sprinkling of fair musk-rose blooms:  
And such too is the grandeur of the dooms  
We have imagined for the mighty dead;  
All lovely tales that we have heard or read:  
An endless fountain of immortal drink,  
Pouring unto us from the heaven's brink.

*Endymion*

John Keats, 1818  
(Lines from *Endymion*, 2010)

## Diana and Endymion

Coloured pencil and oil pastel  
on cartridge paper.

Returning to your artwork, think about how the light from Apollo appears in hues of yellow through the atmosphere. Consider how this yellow light reflects off the clouds, illuminating the horse with yellow light.

1. Using the same yellow brown used previously on the clouds, plus an orange and red-brown, work on the horse and the person pulling the curtain.

Observe how Poussin has taken some artistic licence here. The rump of the horse is shaded darker so that it stands out against the light of Apollo. However this should really be reflecting back the pure source of golden light that comes from Apollo and his chariot. Note also that the front of the horse is lighter than the back, when the reflection from the clouds should be less strong than Apollo's light.

If Poussin had not done this the horse would have appeared less dynamic, and would not have appeared to be pulling the chariot in the right direction. By making the front of the horse light and the back dark it appears to be moving forward. In this way Poussin has made a compromise be-

tween what is scientifically correct and laws of aesthetics that play on our subconscious.

2. Now take a brown and a golden yellow oil pastel and quickly work the rich ground colour onto the base of the picture.

Observe how the use of oil pastels changes the effect of the coloured pencil picture.

3. Taking a blue, a black and a lemon yellow oil pastel quickly work in the curtain colours.

Take note of how it feels to apply this powerful dense colour, and how it feels to draw in the edge of the blue as it forms a hard edge against the golden Apollo.

Observe how the overall balance of the picture changes as you widen the dense blue area of the curtain.

4. Try to stop extending the dark blue curtain when the balance is just right. If you do too much you can crop part of the right side of the picture.







Author's coloured pencil and oil pastel drawing of Poussin's  
*Diana and Endymion*

## Baroque Art

The story is the painting itself

Like Caravaggio and Poussin, Rembrandt also uses stories to relay themes in his pictures, but he demonstrates how painting itself can do this alone. His intense study of facial expression and physiognomy is completely new for its time. Every feature and wrinkle, even the skin texture tells its own story. There is no need to rely on a biblical or classical story to convey meaning as the painting does this itself.

The art historian Van James (2001, p. 22) described Rembrandt as an artist who “could be singled out as one who could draw upon the spirit of his time”. He goes on to say that “Uninterested in the Italian journey prescribed for artists of his time and totally engulfed in the Dutch palette of subdued earth tones, Rembrandt redeems darkness by finding the sacred measure of light within shadow.”

We see in Rembrandt’s work the same highly contrasted use of light that was used by Caravaggio. But Rembrandt’s light moves gently out of the darkness revealing subtle tonal changes that slowly disappear and reappear as they fade in the lights intermittent reflection. He seems to have tenderly observed every detail of his subjects, sculpting out each form while he relished the reflections of each colour as light revealed it. Gottfried Richter describes this by saying;

Faces, gestures and objects come to birth there out of impenetrable shadows, glow gently, are there and fade away again, we feel how all his pictures are really visions of his inner nature, glowing in a mysterious light whose source remains unseen because it lies within his own inner self. (Richter 1982/1985, p. 214-215)

Rembrandt’s painting ‘The Man with the Golden Helmet’ is a beautiful demonstration of this. Look at it in a dark room and the man fades into the shadows, but view it in the light and subtle hints in the darker areas lead the eye to actively join the hidden clues together. The more you look the more you see, as the figure seems to gracefully move out to engage with you.

Figure 3.  
**The Man with the  
Golden Helmet**  
Rembrandt c.1652  
Oil on canvas  
67 x 51.5 cm  
Gemaldegalerie, Berlin



While Rembrandt used subdued earth tones these are still rich in hue, and his colours extend out of the darkness giving the appearance of three-dimensional reality. His fascination with elaborate fabrics and textures give a lifelike quality that surpasses his Dutch predecessors because of his ability to weave this incredible detail in with fading darkness and intense reflection of light. The details of the helmet in the above mentioned picture display this superbly. Strokes of pure white are able to sit by strokes of pure black without any jarring experience of conflicting contrast. Instead the strokes are placed along with strokes of gold and red/brown, which appear to lively gather and disperse around the black and white, carrying highlights to the forefront and pushing darkness into the shadows.

## Science

### Paroptical colours

The chiaroscuro effect so masterly used by Rembrandt, does not make light areas jump out of dark backgrounds directly, there is always a softening of the edges. Goethe (1669/1970, p. 165-170), also noted a softening of edges in his scientific studies. He applied the term 'paroptical' to colour created by an effect caused by light as it passes by an outline or edge.

He explains that the light from the sun is not really light coming from a point source, but that it comes from right across the diameter of the sun. When a shadow is cast by an object intercepting the sun's rays, these rays are at slightly different angles depending on what part of the sun they originate from. This causes a slight double shadow, or graduation around the edges of the shadow. He demonstrates this with the following examples.

#### ACTIVITY A

1. Stand in the sun on a bright day and observing your own shadow.
2. Observe the slight diffusion on the edges, but notice how this is less noticeable the closer the shadow is to your feet. You will

also notice that the bulk of the shadow is darker when it is by your feet. As the shadow gets further away it lightens, and the diffusion on the edges becomes greater.

3. If you then hold up your hand and spread your fingers, you produce what appears as two shadows from each finger spreading apart at the tips and converging at their base.

#### ACTIVITY B

1. In a darkened room, shine a torch onto a white wall.
2. Observe the diffused halo around the light on the wall. If you observe it carefully you should be able to make out a grayish yellow in the diffused halo around the top of the light, and a grayish blue in the diffused halo around the bottom.
3. Now hold up a range of narrow objects, such as a pen, blade or needle, in the projected light and note that not only is there a halo around the edge of the light, but also around the shadow. The halo around the shadow will appear more yellow above and more blue below. Where the halo of the shadow overlaps the halo of the light there will appear a darker shadow.

## Art

### The Man with the Golden Helmet

Chalk pastel on matt black paper

A good way to explore soft edges in an artwork is by using chalk pastels. Using them on black paper very quickly simulates a chiaroscuro effect. Barely touch the paper with them, then rub the colour in with your finger so that it can be barely seen.

1. Take a chalk pastel, ochre or any mid-toned warm colour, loosely map in the shape of the face, helmet and shoulders on black paper.





2. Shade in the face colour using a mix of skin colour and light mustard yellow.

Rub this into the page, maintaining the area you mapped out for the face. This should have a rich velvety texture so you may have to repeat the process 2 or 3 times. This is what is referred to as under painting.

3. Do the same with the helmet area, but this time using mustard yellow and white.
4. Then lightly apply white to the highlights on the shoulders and blend this into the background to diffuse the edges whilst retaining the shapes of the armored uniform.
5. Take a red ochre and draw in the bedding in which the features of the face will later appear. Apply this colour to all the areas of the face where there are shadows, leaving only the highlighted areas.



Rub this ochre in maintaining the shapes of the shadows and highlights. Don't leave out areas that will be darker later, as the red ochre colour will sit beneath these, adding to the depth of colour.

6. Inside this bed of red ochre apply brown tones. Blend these in, but don't completely cover the red ochre.

The brown should look as if it slowly diffuses into a red ochre halo. Pay particular attention to the shape the brown takes because while the face will lack depth at this stage it should still look balanced. Check that the eyes look lined up, and that they are not too close together or too far apart. Check that the nose looks as if it sits evenly between the eyes and that the mouth is in line with it. You can easily make adjustments by rubbing in areas and reapplying the red ochre and even touches of mustard. Work lightly until you are sure things are in the right place, then strengthen the colours.



Once you have made a resolution to no longer adjust the balance then it is time to add black.

**7. Put in the finer details of the face with black, but do this by barely touching the paper and then smoothing the dark marks in retaining their shape.**

This will add detail and depth. Wherever the shadows appear dark, there will be black, even though it only appears dark brown when we look at it. A little black sitting in a pool of brown will appear dark brown, but it will also give the appearance of sculptural depth. Now you need to carefully touch the darker areas with the black chalk and blend these seamlessly into the surrounding browns.

Keep standing back and looking at the effect from a metre or more away, and only add the smallest touch at a time. The darkest areas on a face will be the eyes, under the nose and chin and in this picture, under the rim of the helmet.

**8. Now you can add flicks of white for the moustache and faint beard. Use a sharp part of the chalk and make distinct strokes, observing the lines of the hair in the original picture. Then using a clean finger gently run it down these lines to smooth them in so that they have softened edges and blend in with the rest of the picture.**

Don't over do this, one run over with the finger is usually enough.

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## Spiritual Literature

That sun never sets: nor suffers any cloud, but such as are raised by our passions. It is a day without shadow. It lights the savages even in the deepest and darkest caves; none but sore eyes wink against its light; nor is there indeed any man so distempered and so blind, but who still walks by the glimpse of some duskish light he retains from that inward sun of consciences. That universal light discovers and represents all objects to our minds; nor can we judge of anything but by it; just as we cannot discern anybody but by the rays of the sun.

*The Existence of God*  
Francois de Salignac de La Mothe-Fenelon, 1713  
(Fenelon, 1713, sec. XVIII)

## Science

# Degrees of refrangibility of coloured light.

Newton (1669/2010), explored the refrangibility of coloured light from many perspectives before he could be sure of his theory that coloured light was caused by its degree of refrangibility. We looked at this on pages 11-13, and also on page 20, but below are other experiments he gave that support this idea.

### ACTIVITY A

1. Take a piece of card approximately 3 mm x 12 mm and paint one half (3mm x 6mm) bright ruby red and the other side ultra-marine blue.
2. Place black card or material on the table so that it creates a dark background for the card. Place the card on this ensuring that the surrounding area is light enough so that the card can reflect back its colours clearly.
3. Now hold a prism over the card so that the side you look through is parallel with the card, and adjust so that you can see the refracted card through the prism. Observe the edges of the colours against the dark background.

You will notice that if the prism is positioned so that the refraction moves upwards, then the blue side rises higher than the red on the top edge, and the red drops lower than the blue on the bottom edge. If the prism is positioned so that the refraction moves downward, then the effect is reversed. Newton determined from this that the 'blue suffers a greater refraction than the red' (Newton 1669/2010, p. 23).

### ACTIVITY B

1. Darken a room and create a narrow beam of light. Set the light so that it shines on a wall and ensure you get a round image.

2. Place the prism in the light and angle it so that a refracted spectrum of light appears, and observe the spectrum.

You will find that the spectrum is not round, but rectangular shaped with rounded edges at the top and bottom. Newton (1669/2010, p. 34) perceived the shape projected to be made up of a 'series of different coloured circles of light'. It appears to move from white light to green, blue and violet in one direction, and from white light to yellow, orange and red in the other direction. This suggested to Newton that the light rays in white light contained a mixture of rays which could be refracted at different angles, and that these differing angles corresponded to different colours.

3. Intercepting the projected spectrum with a second prism Newton found that these coloured lights could be further elongated, but retained the same colours, in the same order, with the same proportions to each other.



## Art

# The Man with the Golden Helmet

Chalk pastel on matt black paper

Re-looking at your work after having a rest, you will notice imbalances. Resist the temptation to go over details on the face at this stage. Instead look at the area around it and give this shape.

1. Use some black chalk to reshape around the cheeks and chin.
2. Put in the shadow under the helmet, and define exactly where the rim of the helmet should be, providing a hard line beneath it.

Rub the black hard into the paper, so that it doesn't smudge when you apply the golden tones.

3. Use white for the highlights and lightly apply red ochre to give shape to the helmet.
4. Put in the rim around the bottom, and the rim that goes up from the middle.

Make sure that the middle rim gives the appearance of being in line with the nose. Now use a touch of black to create the shading on the far side of the helmet.

5. Using some white, red ochre and a touch of black, put in the helmet strap.

Note that it is only the highlights of the strap that can be clearly seen. However once this is done, it will make the face appear more in balance.

6. Put in the ornamentation of the helmet. Start with the band around the edge, using red ochre, mustard yellow, black and white.



Observe how the light moves around these regular shapes, as they curve around the shape of the helmet. Leave the white reflections until the whole helmet is finished, and put them in last.



## Science

### Catoptrical colours

Goethe (1810/1970, p. 154), observed that colours were not only created from refraction, but also from reflection. He called these 'catoptrical' colours, saying that these resulted from colorless light on a colorless reflective surface.

#### ACTIVITY A

1. Take a tangled length of steel wire and place it under a direct light in a dark room.
2. Observe the light reflections.

You will observe that these condense to points, and in each point you will see that it appears tinged with green and red. 'A prolonged inspection would produce the other colours' too. (Goethe, 1810/1970, p. 155)

#### ACTIVITY B

1. Repeat activity A, but diffuse the light by putting a thin layer of paper over the light source.
2. Observe the light reflections.

The reflections on the wire will appear as long hairlike lines. These too will be slightly coloured.

#### ACTIVITY C

1. Observe these coloured reflections close up through a lens.

The colours disappear and are just bright light, but the roundness or hairlike appearance remains.

Goethe evaluated from this that the shape of the reflection in diffused or strong light was objective, but the appearance of colour in reflection was subjective.

## Spiritual Literature

But among those stars I perceive the moon, which seems to share with the sun the care and office of lighting us. She appears at set times with all the other stars, when the sun is obliged to go and carry back the day to the other hemisphere. Thus night itself, no with standing its darkness, has a light, a duskish indeed, but soft and useful. That light is borrowed from the sun, though absent: and thus everything is managed with such excellent art in the universe that a globe near the earth, and as dark as she of itself, serves, nevertheless, to send back to her, by reflection, the rays it receives from the sun, and that the sun lights by means of the moon the people that cannot see him while he must light others.

*The Existence of God*  
Francois de Salignac de La Mothe-Fenelon, 1713  
(Fenelon, 1713, sec. XVIII)



## Art

# The Man with the Golden Helmet

Chalk pastel on matt black paper

Spend some time looking at the reflections on the helmet. Ask yourself if these are reflections from a strong or diffused light? Then observe how the shapes of the ornamentation contract as they move around curves. Look at how the shadows are a faint red ochre close to the main reflection, and yet red ochre is the highlight colour where the bulk of the helmet is in shadow.

1. Using red ochre, mustard yellow, black and white lightly draw in the other patterns on the helmet.
2. Gently darken the edges of the helmet so that they fade into the background.

This should be done to a greater degree on the far side of the helmet, to the right, where only an oc-



casional faded ochre highlight should determine the shape.

3. Then put in the white highlights.

Starting with the central part of the reflection, push hard with the chalk leaving solid un-blended strokes. Then gradually work your way out in a circular motion, picking out the highlights as you imagine them bouncing off the raised decorations. Work lighter with the white chalk as you circle outwards.



## Science

# Coloured Edges and Borders

Goethe put forward the idea that colours were not only created from refraction and reflection, but also from the combination of light and dark. He demonstrated this in the following activity.

### ACTIVITY A

1. Place a black paper over a white background and look at this border refracted through a prism. You will get a thin yellow strip that Goethe called an 'edge', and then a wider strip of yellow that Goethe called a 'border'. (Goethe, 1810/1970, p. 87).
2. Place a white paper over a black background, and you will get a blue edge and a violet border.
3. Place a thin white strip on a black background and the refracted colours will be able to meet. They will form a sequence that goes from orange, to yellow, green is formed in the middle, and then there is blue and violet.
4. Place a thin black strip on a white background and the refracted colours will also be able to meet, but this time a red will be produced in the center. You will get blue, violet, red, orange, yellow.
5. Try this again, and if the strips are narrow enough and the refraction is tilted to further expand the bands of colour you will narrow the colours down to orange, green violet, on the white background, and blue, red yellow on the black background.

Further more Goethe discovered that the ways in which refracted colours behave in relation to dark and light, changes according to the relationship between the dark and the light. Grey for example, can behave as dark or light, depending on what it is placed beside (Goethe, 1810/1970, 103-105).

### ACTIVITY B

1. Look at a gray strip on white and it appears dark. Look at this refracted through a prism, and it will behave as the black strip on a white background did in the previous activity.
2. Place the same gray strip on black, and it will appear light. Look at this refracted through a prism and it will behave as the white strip on a black background did in the previous activity.
3. Put the same gray square on a background that is half white and half black. Look at this refracted through a prism, and you will see it behaving differently on the white background, to what it does on the black.

But not only do black, white and gray behave in this way, but Goethe found that colours too 'have a degree of darkness or lightness', and as such they behave in the same way as the gray in the activity above in regards to how they refract colours (Goethe, 1810/1970, 106-113).

### ACTIVITY C

1. Put a violet-blue, a red and a yellow on a black background. These colours are all lighter than the black, and so they will behave as the white strip does on a black background. However the border and edge will be narrower on the violet-blue, than on the red, and the yellow will have the widest and most prominent coloured edges and borders.
2. Use the same colours on a white background. These colours are all darker than the white and so will behave like black on white, however the borders and edges will be greater on the violet-blue, less on the red, and the least prominent on the yellow.

### ACTIVITY D

1. Look through the prism at objects around the room, and observe whether they behave as light on dark, or dark on light.



## Art

# The Man with the Golden Helmet

Chalk pastel on matt black paper

We can begin again by studying the picture, and re-familiarizing ourselves with it. Look at the diffused edges. It is easy to imagine how these grayish tones are made up from coloured borders and edges.

**1. The next step in this painting is to draw in the feathers at the top of the helmet. Use a pink and a deep magenta for this.**

Study the form of the feathers first, thinking about the shape of the middle seam of the feather's shaft, and how the soft fibres fan out from it in a regular pattern tapering out at the end. Now look for the curved shapes of the feathers main vanes in the picture, and lightly draw these in. Now using a sharp edge of the chalks, make clear regular strokes simulating the soft fibres of the feathers. Alternate between magenta and pink, using the original picture as a guide. Soften the edges by lightly running your finger over these strokes, following their form.

**2. For some finishing touches, you can use black chalk around the edges tidying up the overall shape of the feathers, and run a few black lines between the fibres to show where the feathers have been ruffled.**

**3. Now work on the clothing using red ochre, skin pink, and white and tidying up the edges with black.**

Study the clothing for a while before you begin. You will notice that the overall shapes of the clothing start to move forward out of the darkness. Very little is actually drawn in, just a mix of soft and in-



tense highlights, however your eye should be able to put the clues together so that you can see what the whole shapes are. Make sure when you draw in these highlights that they form patterns that allow anyone looking at your picture to be able to piece them together and create the shapes of the clothing.

If you look at the strongest reflection on the helmet and follow this down you should be able to see that the brightest part of the face is directly below. Then if you imagine a shoulder coming out on an angle to the left from the neck, then you can imagine how this shoulder would catch the same light. This is where you put the brightest reflections on the strap going over the shoulder. Create a soft bed of faint white, smudged into the paper with soft diffused edges, and then apply solid hard strokes of white where the strongest reflections are.

Have a look over the whole picture and check it for last minute touches. In my picture I noticed that the right side of the face and helmet were still too light, so I darkened it and then the picture looked more balanced.

Author's chalk pastel drawing  
of Rembrandt's  
*The Man with the Golden Helmet*



## Spiritual Literature

Therefore the highest and most general problem of philosophy is exclusively this - to apprehend and fix the essential in that fleeting chaos, to display it as the essential and good therein, and so drawing forth to the full light of consciousness to apparent contradiction between those two intuitions, to reconcile it at the same time.

*Introductions to the Dialogues of Plato*  
Schleiermacher; 1836  
(Schleiermacher; 1836, p. 385)



# Baroque Art

## Inner Space

Baroque Art is strong, dynamic, and it bursts forth with an array of vibrant glowing colours that shine out of darkness, creating depth out of which internal spaces appear to grow. The Renaissance did this with linear perspective, now the Baroque Art does this with both linear and colour perspective, intensified by a fascination with reflections, and shadows.

Richter (1982/1985, p. 209), describes this inner space by saying it forms into individual space within itself which “growing out beyond itself, it begins to speak with other spaces, to sense and to affirm their existence as self-contained spaces. And yet it goes on to overcome all this”.

We see in Velázquez's painting 'Las Meninas' that the main characters are in the middle ground, and before we reach them we need to enter the space between us and the canvas on the left side. We move through one space and then enter another. The same can be said of Jan Vermeer's 'The Art of Painting', where again the characters are in the middle ground and we need to enter the painting on this side of the hanging curtain before we can enter the space where the characters are.

What happens next in both these works is another trait of Baroque art, which Richter describes as even

more significant, when not only another interior space but the outside world itself 'intrudes', through a half-open window, say, or even a translucent one. Whenever this occurs, doors and windows take on an even stronger 'threshold' character than if they would merely lead from one interior space to another. For even though the outer world is something alien, 'otherness' itself, it is still waiting to be entered so that it, too, may become interior space. Interior space is growing out into the external world. (Richter, 1982/1995, p. 211).

In 'Las Meninas' the open door at the back leads one to wonder whether the man in the doorway is entering bringing in something new, or leaving to explore something else. Likewise in 'The Art of Painting' the glow coming in from behind the curtain not only lights up the subject being painted, but makes us wonder what might also enter from that other space, or whether Clio, the patron of history, might walk out through it. (Krauss, 2005).



Figure 4.  
*Las meninas (The Maids of Honour)*  
Diego Velázquez 1656  
Oil on canvas  
318 x 278 cm  
Museo del Prado Madrid.

In both these paintings the figures within them are not the main theme, but rather the theme is the interplay of space. The characters are secondary, they are there because of the way they interact in space. Both paintings show the artist within the painting, his own interaction in space is a part of what is being explored. Both paintings show the subject the artist is painting. Both artists use compositional elements to lead the eye around the picture. But where Vermeer leads the eye out behind the curtain along the line created by the instrument that the patron of history holds, Velázquez takes the viewer into a whole new aspect of space.

On first view it is easy to assume that Velázquez is painting the possible heiress to the Spanish throne, the Infanta Margarita, seen here in the white dress surrounded by her maids, and other courtiers (Krausse, 2005). But the title suggests that the main subject is the Maids of Honour. However if we look more carefully, we are drawn in to an even deeper meditation. What is it, that the Infanta, the dwarf and Velázquez himself are looking at? Is it us? Is the artist exploring us the viewer in a whole new realm of space?

Yet if we follow the artist's visual clues even further, we see the man in the doorway with his head facing to the left with his arm acting as a vector that also leads us to the left. And if we follow the repeating occurrence of light fittings on the ceiling to a light patch between the paintings on the back wall, we find another group of vectors that lead us down to the same place. We come to what appears at first to be another painting. But why is this painting brighter than the others? And why are the figures in it so diffused?

This is in fact a mirror. Velázquez shows us what he is painting and in the process unfolds yet more spaces. We can explore the illusive space created within the reflections of the mirror, along with its reflection of light and refraction of image. Now we are led to consider the space outside the picture, the space where the couple reflected in the mirror, most likely the king and queen, would be standing.

When Luca Giordano the Italian Baroque painter saw 'Las Meninas' he exclaimed "This is the theology of painting! And continued: 'As theology embraces all the individual sciences so this picture embraces all the possibilities of painting'" (Krausse, 2005, p. 39).



Figure 5.  
***The Art of Painting***  
Jan Vermeer 1665  
Oil on canvas  
120 x 120 cm  
Kunsthistorisches Museum, Vienna  
(The art of painting, n.d.)



## Science

### Catoptrical colours continued

The inner space in reflective objects was also of interest to Goethe. We saw on page 31 how the reflections on steel wire could show colours, particularly red and green. But Goethe did many other experiments investigating the creation of colour in objects with reflective properties. He gave the following examples as evidence for this.

#### ACTIVITY A

1. Look at a polished reflective surface such as silver or glass with scratches on the surface, and catch a strong light reflection in this material. You can now observe an iridescent appearance. You may need to look from one side to see colours, but green and red are usually the most prominent.

#### ACTIVITY B

2. On a shiny piece of brass or copper make a greasy finger mark. Then hold this up to reflect a strong light. The iridescent effect is more noticeable if you also hold up black

card, without blocking the light, so that this reflects on to the metal where the finger mark is.

#### ACTIVITY C

3. Hold up a reflective material that has sharp raised protrusions on it such as a cheese grater. Hold this in a bright light and looked at from an angle you can observe the iridescent light forming in small points on the tips of the raised edges.

In each of these examples Goethe (1810/1970), explained that the colours were caused by a meeting of light and dark on the reflective medium. In the case of the scratched line it is a thin line of dark on light. The fingerprint creates an edge, and the sharp protrusions of the grater create spots of dark shadow on the light surface. Look at each of these through a prism and the effect will be spectacular, but the colours can be seen even without the prism.

## Art

### Baroque exploration of inner space

Acrylic painting on acrylic painting paper

The Baroque artists used reflective objects as a way to further their exploration of inner space. Scientists such as Goethe explored how the reflective properties of these objects created colour within these inner spaces. Our next artistic activity will be to explore for ourselves, light, colour and reflection in relation to the composition of inner spaces.

Velázquez's 'Las Meninas' is too complex for most young students to paint, so I have composed a simpler picture to work from (p. 47). In this picture the eye first looks at the bottom right third of the picture, the golden section. There is nothing here but the blue tablecloth to hold our attention, so the eye is either pulled towards the crystal or

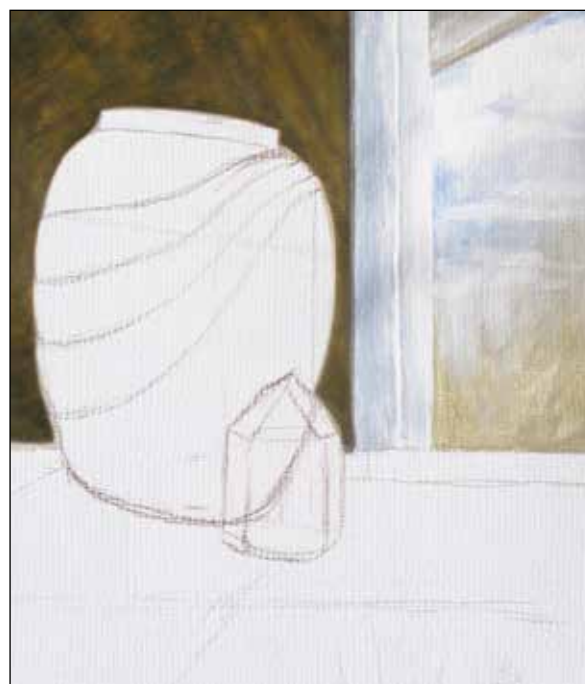
it follows the vector created by the window frame and moves upwards. Moving up the eye follows the vector of the overhanging roof line. Then the vector created by the blue meeting the edge of the clouds directs the eye down in a loop, along the skyline between the trees and the blue, and brings the eye back inside the window. In this way the eye is taken on a journey outside the window and then brought back in. It is then directed to the same space it may have gone to at the first option, where it explores the inner space of the crystal with its refractions of light, bouncing back and forth from the many polished faces. The crystal then points the eye upward, where it can investigate another space, where the image of the artist shines back from the reflective bronze. The decorative lines of the vase then lead the eye back out the window, from where it continues on with its cycle.

Students may want to compose their own painting using compositional vectors to lead the eye around the page. They would need to include other spaces, such as windows, doorways, mirrors and light refraction inside crystal objects. Students could then photograph their compositional layout and work from the photograph. Students would need to have a reasonable amount of experience working with acrylics to paint this. They may wish to create their own composition photographically, but paint the picture provided in order to follow the painting instructions that are given.

1. Using a brown coloring pencil (avoid using graphite as this will show through the paint) Lightly sketch in the main forms of the painting.
2. Mix up a dark brown and paint in the wall behind the vase.
3. Go over this with mustard yellow, applying this with a dry brush so that it creates a texture, and so that the dark brown can still be seen underneath.



4. Using black and a dry brush feather out some darkness at the base of the wall where it meets the table and fade this out as you work upwards.
5. Do the same along the edge of the window frame, but keep this as a narrow strip of darkness. The window frame only casts a narrow shadow.
6. Paint in the window frame.





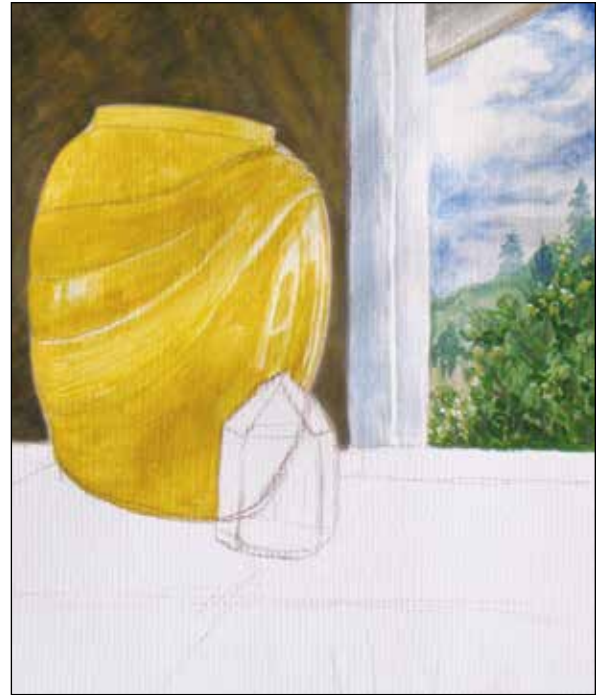
Note that although the frame is white, pure white is only seen where the light reflects directly off it, and this is only on the edges. The rest of the frame is pale blue-gray. To do this put wet white and pale blue-gray together, and using a clean dry brush, drag the brush over the two colours so that they blend together.

#### 7. Paint the clouds outside the window.

The same technique is used to create the clouds in the sky outside the window, except that you do this while creating rounded cloud shapes rather than straight lines. Note that in general, clouds are more curvy at the top and flatter at the base.

Also note that in this picture, the blue outlining the white cloud on the far right is used to direct the eye back into the page.

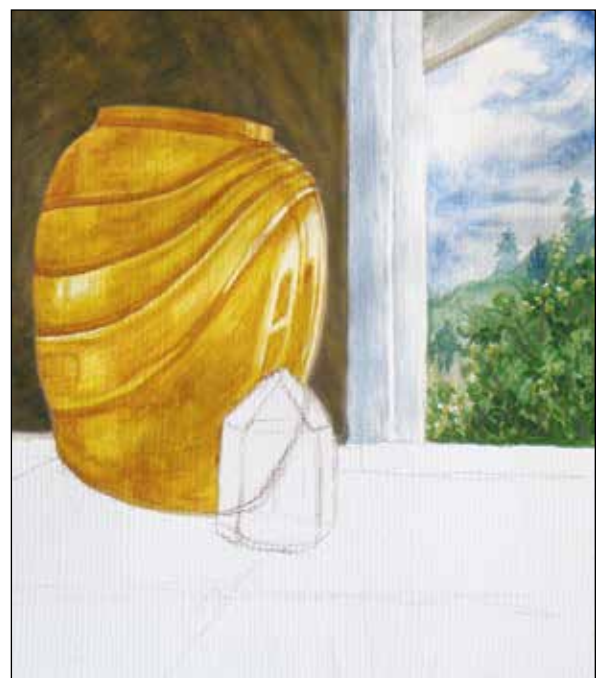
#### 8. The next step is to put in the green area outside the window. Start with the hillside in the distance. Mix a thin pale blue-green



and apply this to the hill remembering to include the trees on the skyline.

#### 9. Bring this colour right the way down, and before it is dry apply some thick forest green along the bottom feathering this upwards with a dry brush.

#### 10. When this is dry, use an old rough brush and stipple in thick dark forest green, sap green and lemon yellow to create the bush.







Observe that all three colours are all over the bush, but dark green is more prominent at the bottom, and sap green at the top, while lemon would appear where reflections would occur.

**11. Mix mustard and golden yellow and apply a thin coat to the vase, leaving out the areas where the strongest reflections are.**

White acrylic can be used to paint over darker acrylics, but light colours will lose much of their brightness this way. Therefore, it is better to leave areas bare where light colours will be later.

**12. Go over the vase a second time with a thicker coat of the mustard and golden yellow mix, but leave more space around the white areas you left in the first coat.**

This will give the white areas a slight gleam.

**13. Mix a thick orange-brown and using a small flat brush, work in the shadow areas on the vase.**



As a technique, apply the paint with one brush and feather it into the base colour using another brush that is dry.

**14. Apply thick white paint to the shiny areas, feathering it in as it overlaps the yellow.**

**15. Paint in the reflection using skin tone and brown. Add warm red and violet borders.**

Once the vase is finished and looks evenly rounded then it is time to paint in the reflection of the figure. You can make this a figure of yourself if you want to. Because the light will be lighting up the background behind the figure, the figure will appear darker than the background and darker still on the side blocked from the light. This will be on the left side of the reflection. A faint violet will appear on the right edge of the dark figure and a slight red/orange on the left edge. Note that due to the rounding of the vase, the figure will appear narrow and elongated from top to bottom. Remember also to paint in the edge of the table, and note that when you do this that the bottom of the vase, where it is in the most shadow, will not reflect so the reflection needs to fade out.



## Spiritual Literature

Let us, in the first place, stop at the great object that first strikes our sight, I mean the general structure of the universe. Let us cast our eyes on this earth that bears us. Let us look on that vast arch of the skies that covers us; Those immense regions of air, and depths of water that surround us; and those bright stars that light us. A man who lives without reflecting thinks only on the parts of matter that are near him, or have any relation to his wants. He only looks upon the earth as on the floor of his chamber, and on the sun that lights him in the daytime as on the candle that lights him in the night. His thoughts are confined within the place he inhabits. On the contrary, a man who is used to contemplate and reflect carries his looks further, and curiously considers the almost infinite abysses that surround him on all sides. A large kingdom appears then to him but a little corner of the earth; the earth itself is no more to his eyes than a point in the mass of the universe.

*The Existence of God*  
Francois de Salignac de La Mothe-Fenelon, 1713  
(Fenelon, 1713, sec. X)

## Science

### Mixed Colours make White Light

Newton (2010, p. 135), proposed that white light 'is compounded of all the primary colours mix'd in a due proportion'. He was able to demonstrate this with coloured light projected from a prism.

#### ACTIVITY A

1. As done in earlier activities, darken a room, create a narrow beam of light, and shine this through a prism so as to cast a spectrum on a flat white area.
2. Place a lens in front of the projected spectrum so that the rays converge.

3. Take a piece of white card and move this back and forward along the rays of the projected spectrum, so that you can see the spectrum converge to a point, and then get larger again.

Observe how when all the colours converge to the same point, that the colours disappear and the light is white. Note that as the rays continue on their journey and separate again, the colours reappear in reverse.

### ACTIVITY B

1. Set up the same activity as above, but position the paper at the converging point so that it remains in that place.
2. Block individual coloured rays, and the white light on the paper will change to a colour, that corresponds to a mixture of the remaining coloured rays.

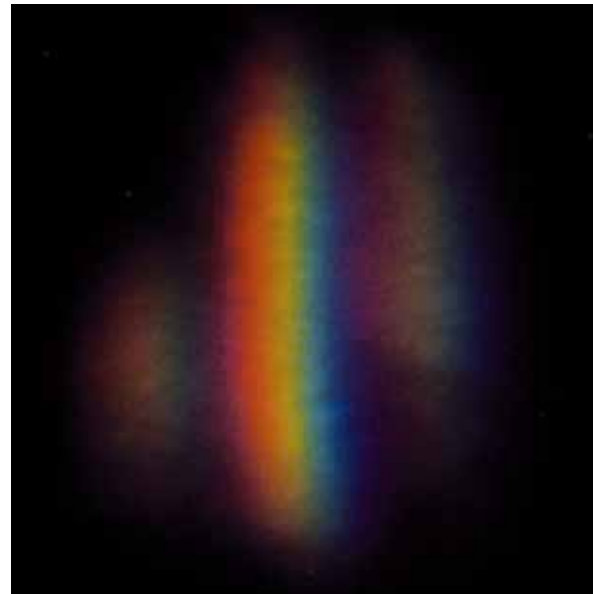
Thus Newton found that coloured light can be mixed to create other colours, but mix all colours in the right proportions and you make white light.

### ACTIVITY C

1. Use the same set up as above, but remove the lens and intercept the light going into the prism with a comb.
2. Coloured stripes of all the colours will appear in the right proportions to make white light if mixed. Move the comb up and down quickly and the colours will appear to mix and white will replace the coloured stripes.

### ACTIVITY D

1. Froth up a bowl of bubbles and shine a narrow beam on these in a darkened room. The reflection on these will appear white, but if you look at these reflections closely you will see that they are tiny spectra of colour.



## Art

### Baroque exploration of inner space

Acrylic painting on acrylic painting paper

Newton found that colours could be mixed through variations of coloured light. The same can be done with colour pigments. However if you mix all the primary pigments together in the right proportions, you get black, rather than white.

1. Mix up three shades of blue, one intense in colour, one with some black added, and one paled down with white. Apply these to the tablecloth. Use the same blending technique suggested for the cloud colours.

Note that when mixing light colours, it is best to start with white and add a little of the main colour at a time. Very little colour is needed to mix with white to create a pale colour, so if you start with the blue, you may need to use a whole tube of white before you get the right shade.

Apply each tone where it appears most prominently and then apply the ripples over the whole surface of the blue, using either intense or dark blue depending on what colour you place them on. Apply the highlights where the ripples

sit in the sun's path. Finally darken up the shadow closest to the vase, and note there is a very slight shadow directly under the crystal. Then add the darker parts of the folds on this side of the tablecloth as it drops down.

Spend some time observing the crystal before you begin to paint it. There are cloudy areas in the formation of the crystal that retain the white light, and the different faces are coloured or white depending on the angle at which the light is reflected. Some white areas have a coloured sheen when looked at carefully. There are soft blues, pinks, yellows, greens, grays, and traces of the bronze inside it. The edge of the vase is refracted and is out of line with the actual vase. Also a reflection of the crystal needs to be painted on the vase.

2. Mix slightly tinted whites to a thick, yet fluid texture for most of the crystal. Apply it with a small flat brush to get a flat surface in a small area.

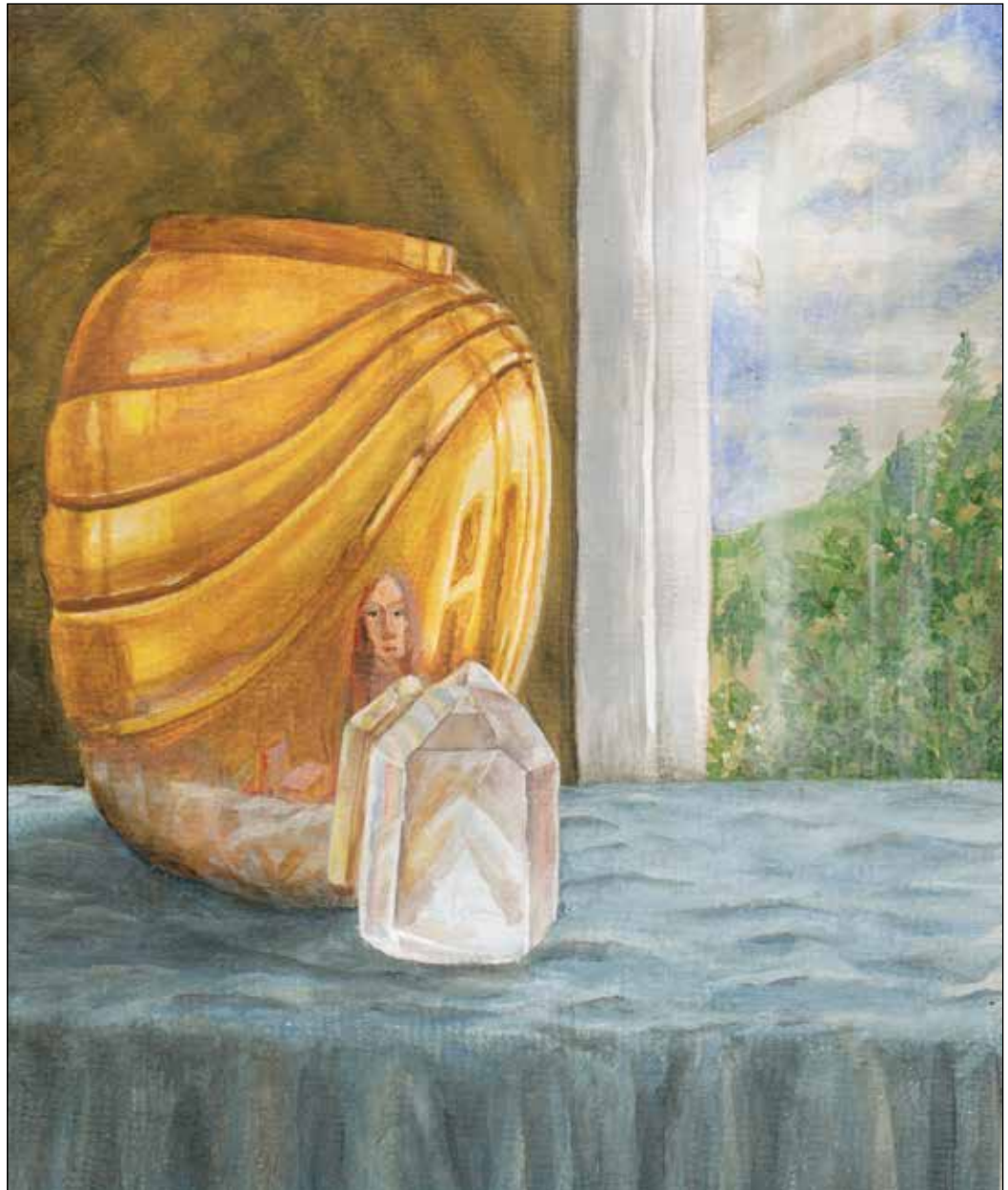
3. Use thick pure white with a fine brush to bring out the finishing touches and create the sparkling reflections.
4. Paint the reflection on the window. Mix a translucent acrylic medium with a touch of white and drag streaks down over the window.



## Spiritual Literature

Just as in the prism a white ray of light is split up into seven darker shades of colour, so the divine personality or Ego has been broken into countless susceptible substances. As seven darker shades melt together in one clear pencil of light, out of the union of all these substances a divine being would issue. The existing form of nature's fabric is the optical glass, and all the activities of spirits are only an endless play of colours of that simple divine ray. If it pleased Omnipotence someday to break up this prism, the barrier between it and the world would fall down, all spirits would be absorbed in one infinite spirit, all accords would flow together in one common harmony, all streams would find their end in the ocean.

*Schillers' Philosophical Letters - Theosophy of Julius*  
Friedrich Schiller 1786  
(Schiller, 1786, b, parag. 2)



Author's acrylic painting based on a Baroque composition



## Rococo Art

During the rule of the Sun King the French court was the envy of Europe. Absolutism was the preferred way to rule, lavish lifestyles were something to look up to, and Baroque Art flourished. Art took the form of large-scale heroism, be it classical, religious or the glorification of the European rulers. While artists may have tested the boundaries of these themes, spreading out into space as the main subject, the components of the paintings were still tied to the interest of the monarchs. Louis XIV of France was the most influential of all, a dictator of aesthetics, and the aristocracy of the day, both in and outside of France, followed the fashions he set. But Louis XV and XVI were not so popular, and steadily lost power while the French aristocracy gained it. This change that began in France eventually led to the French revolution, and spread to other countries.

Such a change in views and power had its effect on art and this change began in France with the Rococo style. It was a turn away from large-scale heroism, with its suitability for grand palaces, and a movement towards a glorification of the pleasures of life, something more in tune with the lifestyles of the aristocracy. Artworks had a decorative intimacy, they were joyful and playful and became much smaller so as to be suitable for large houses as opposed to the wall-sized historical works of the palaces.

Krausse (2005, p. 47), describes Jean-Honore Fragonard as “a master of the cheerful and playful Rococo style”, and says he “knew how to translate simple activities and situations into tasteful, aesthetic scenes dedicated solely to love and beauty.”

‘The Swing’ was commissioned by a treasurer of the French clergy. “The client wanted a scene in which a lover - who can be seen amongst the rose bushes in the left foreground - would have opportunity to look under the skirts of his mistress” (Krausse, 2005, p. 47). It shows a playful scene in a delicate painting style with its gentle composition, its soft colours and perfect colour balance.

The dynamic movement and high contrast lighting of the Baroque art is gone. It is replaced with a movement suggestive of a light ruffling breeze. Soft light illuminates the scene, lighting up pastel colours that provide a gentle colour contrast of pale complementaries. There is still the darkness to contrast with the light filled area in the middle, but this is pushed to the periphery serving as a frame that brings the main subject to the fore and creating depth. Delicate detailed pastel coloured leaves and flowers are painted over the dark outer areas, forming intricate patterns that resemble lace. The luxurious frills of the dress are painted in a way that resembles flower petals because the light both reflects off and shines through them. The pale orange and warm red details, with its rippling folds sits gently in a soft glowing complimentary blue and green, surrounded by a frame of deeper colours which cushion it into place. Block off the golden highlights of the tree root in the bottom right and the branch in the top left, and the orange would remain stationary, as if suspended in space. However the yellow glow

Figure 6.  
**The Swing**  
Jean-Honore  
Fragonard 1767  
Oil on canvas  
81 x 65 cm  
Wallace Collec-  
tion London



has the effect of attracting the orange to it, appearing to pull it towards the root and then back towards the branch. The picture is perfectly balanced. Not only is there a balance of light and dark and of complementaries, but even the movement created by the position of colours is perfectly controlled. The eye is not only kept on the page but just the right sense of movement is created so as to replicate the movement of the swing.

## Science

### After vision of light

Fragonard's painting of 'The Swing' utilised the balance of complimentary colours and dark and light. This is not just an aesthetic principle. Goethe found that the eye always seeks such a balance itself. That dark and light as well as colour, leave an after effect in the eye itself. They leave a mark on the retina, which gradually mends itself and in the process creates colours. He gave the following activities, to experience how light and dark do this (Goethe, 1810/1970, p. 16-18).

#### ACTIVITY A

1. In a darkened room look at a bright light.
2. Look at this for some time then turn your head to face a dark area of the room.

You will be able to observe the shape of the light in front of you. The middle of this shape will appear colorless, or slightly yellow, and the border will appear red. Slowly the red will spread inward and take over the yellow, and as it does so a blue border will appear. The blue will then repeat the pattern taking over the red, and as it does the edge becomes darker with a colorless area surrounding this. Gradually this will close in on the shape, the blue will become smaller until it becomes a dark spot, which will be replaced by a colourless spot which will gradually disappear.

#### ACTIVITY B

1. Repeat the exercise above, but then open the blinds and look at the after image against a light gray surface.

This time the image appears dark and becomes encircled by green. The green moves in toward the middle and as it does so it is encircled by a

dingy yellow, which takes over just as the blue did in the last activity.

#### ACTIVITY C

1. Place a white card and a black card in front of you. Then repeat activity B.
2. But instead of looking at the gray wall, look from the white piece of card in front of you, to the black one.
3. Watch as the colours change in your own retina, in relation to light and dark backgrounds before you.

## Spiritual Literature

The sun, it is said, is only a type of the essential absolute good - the corporeal light bears a precisely similar relation to the spiritual, and when contemplated from the spiritual region is nothing but darkness, in which every mind gropes about which is enchanted by the charm of the terrestrial sun, and, without endeavoring to rise higher, lingers among the material things illuminated by it.

*Schleiermacher's introductions  
to the dialogues of Plato*  
(Schleiermacher, 1836, p. 385)



## Art

# Rococo Composition

Acrylic paint on acrylic painting paper

The complexity and detail in Fragonard's 'The Swing' would be too much to ask an average teenager to paint. But since the composition in itself is quite simple, it can be replicated using a simpler subject matter. Since the whole scene gives the sense of an orange-red flower sitting in a bed of green, then this perhaps is the easiest way to repeat the composition.

1. Use a light brown coloured pencil and loosely map in the composition.
2. Mix a white with aquamarine blue to a liquid consistency and apply a flat coat to the background area.

Leave the flower area and some of the leaves, as you will need the white of the page to bring out the reflections on these later.



3. Mix a darker forest green to the same consistency.

You should now have two reservoirs of paint colour to work from, the forest green and the light aquamarine.

4. Mix just a little forest green into the aquamarine and use this to paint in ghostly images of leaves around the central light that sits just behind the flower.
5. Mix in a little more forest green into the aquamarine base, and paint in slightly darker leaves framing the pale aquamarine light.
6. Continue this process until the coloured leaves change into the darker forest green. Sit these dark green leaves at the base of the light area and in the background below and to the right of the flower.

Observe the feeling you get when working with the aquamarine and green. This feeling should change when you begin to use the next colour.



As you intensify the next colour you should get a sense of inner balance.

7. Mix a pale orange to a thin consistency and paint in the petals of the flower leaving out the highlights.
8. Apply white to the highlights and while both colours are still wet feather them in together with a dry brush.

9. Mix a pale orange, slightly more vibrant than previously used, and paint in the petals again leaving some of the previous colour around the highlights.

Pay special attention to the shapes and folds of the petals at this stage, and make sure that a bed of this orange is made on which to sit the darker shades later.

## Science

### After Vision of Colours

Goethe found that not only did dark and light leave an after effect on the retina of the eye, but colour did so too. This effect achieves a temporary balance with what the eye is seeing and gradually disappears as the eye corrects itself. In the case of colours, the after vision is of the opposite colour to the colour looked at. Goethe (1810/1970, p. 20-26), demonstrated this with the following activities.

#### ACTIVITY A

1. Place a small piece of coloured paper on a white background in a moderately lit room.
2. Look at the coloured paper intently for a short time. Then move the coloured paper away leaving the white background in place.

You should be able to observe a different coloured image, the same shape as the piece of paper, in its place. This image will be the opposite colour to the one you originally looked at. Yellow will produce purple, orange will produce blue, red will produce green, and vice versa, just as mixes of these colours will produce the mixes of their opposites.

With this next activity, it is interesting to point out that Goethe also noticed that coloured light over a broad area had a particular effects on human emotions. He gives the example of the mood of expectation created in the red glow of a sunrise, and points out how other colours have other effects on the emotions. Observe this as well as the effect of after vision in the next activity.

#### ACTIVITY B

1. Put on a pair of coloured glasses, and look around the room with these for a while. Your eyes will adjust to the effects of the coloured glasses.
2. Now take them off and observe what happens.

If you were wearing blue glasses, the room around you will now appear to have an overall orange tone to it. Likewise purple glasses will make the room appear to be bathed in yellow, and so on.

The eye seeks to correct itself, and always bring itself back to balance. However Goethe found that this did not just happen successively as in activities A and B.

### ACTIVITY C

1. Organize a large area of colour such as a coloured wall or large sheet of card.
2. Place a relatively small piece of white paper on this and observe what happens when you look intently at it.

The white paper will take on the opposite colour to that of the background. Thus the eye adjusts

what it sees to create balance simultaneously. This need to maintain colour balance is why Goethe refers to opposite colours as complementary colours. He also noted that the opposite of primary colours, such as blue, red, and yellow, are made up of the remaining two primary colours. For example purple is made up of blue and red and is opposite to yellow. Therefore he considered triads of such colours to be harmonious colours.

## Art

### Rococo Composition

Acrylic paint on acrylic painting paper

When you look at the picture after having a break from it, you will immediately notice whether anything is out of balance. Since this picture does not yet contain specific details, you will not get side-tracked looking at the forms, what you will notice is the colours.

The orange and blue are complementary colours. If you ask yourself whether the orange, blue and green are in balance the answer is no. The picture may have gained a sense of improved balance when the orange was introduced, but the flower needs to include much redder hues to balance the green. And since we intend to bring in more green with the leaves, we need to bring in much stronger red. However when we do this we must leave enough of the pale orange to keep the light blue in balance. Also we need to retain just enough darkness to balance out the light, while retaining the soft pastel effect that is a feature of Rococo art.

1. Darken up the shadows on the flower with a deeper warm red, being careful to retain the lighter areas of the petals.

Note that where the shadow is greater, the light areas are in fact more coloured than they are when fully exposed to the light. The flower will now have more of a three dimensional effect, and will balance nicely with the background. Observe for a moment, how this feels.



Now you will intensify the red even more, and in doing so throw the picture out of balance again.

2. Add a touch of crimson red to the shadow side of the flower towards its center allowing this to feather out into the warm red, which moves softly into the orange.
3. Then darken the crimson paint with a touch of black and paint in the darkest parts of the flower.

It will now stand out much more prominently, and yet it will appear to call for more green to bring it back into balance.

4. Mix a sap green to a medium consistency and paint in the leaves.

As you do so, watch how the flower becomes more and more in balance with its background.



## Spiritual Literature

‘As in the stellar firmament there are sometimes two suns which determine the path of one planet, and in certain cases suns of different colours shine around a single planet, now with red light, now with green, and they simultaneously illumine and flood it with motley colours: so we modern men, owing to the complicated mechanism of our “firmament”, are determined by DIFFERENT moralities; our actions shine alternately in different colours, and are seldom unequivocal - and there are often cases, also, in which our actions are MOTLEY-COLOURED.’

*Beyond Good and Evil*  
Friedrich Nietzsche, 1886  
(Nietzsche, 1886, parg. 215)



## Science

# Effects of Dark and Light on the Eye

Goethe found that not only did brightness, darkness, and colour change in the eye to create balance, but that the appearance of size could also change in it. He demonstrated this with the following experiments (Goethe, 1810/1970, p. 6-12)

### ACTIVITY A

1. Take two circles of the same size, one black and one white, and place them on backgrounds of their opposites.
2. Position them so that they sit side by side.
3. Now observe the size of the circles.

The dark circle on a white background, will appear  $\frac{4}{5}$  the size of the white circle on the black background. Repeat the exercise with a black circle  $\frac{1}{5}$  bigger, and both circles will appear the same size. He concluded that darkness relaxed the eye while brightness excited it, and that this was the cause of the effect.

### ACTIVITY B

1. Hold a ruler in front of the sun, or some other bright light, so that the ruler half covers the light.
2. Observe the effect of the light on the ruler.

The ruler will appear to indent where the light is, as if the rays are able to stream out and brighten the ruler. However the ruler is too far away from the light source for this to be the case. The effect is caused by the light affecting the retina.

Goethe then uses this effect to explain why dark shapes can sometime appear to have light halos.

### ACTIVITY C

1. Look at a dark object with a semi-lit light background. Look at the object for a while so that it burns its image in your retina.

The light after-image will appear wider and will thus give the appearance of a light halo around the dark image you are looking at. This will be more the case if you move your eye slightly to the side, thus moving the bright after-image to one side of the image you are focusing on.

Goethe goes on to explain that where the eye sees darkness, its effect on the retina is to make it relaxed and susceptible. Where the eye sees light, it is excited by the brightness. When we then look at a neutral area, the part of the retina that was excited by the light can now only see darkness in comparison. However he also shows how lightness and darkness are relative to each other.

### ACTIVITY D

1. Hold a dark object up in front of a gray wall and look at this for a while. Then take the object away and observe what you see.

Where the dark object was you will now see a light area on the wall.

2. Now hold a bright object up in front of the same gray wall under the same lighting conditions and look at this for a while. Then take the object away and observe what you see.

Where the bright object was you will now see a dark area on the wall.

## Art

# Rococo Composition

Acrylic paint on acrylic painting paper

Returning to the Rococo picture you will notice that while the colours now form a complimentary balance the flower now seems disconnected to the rest of the plant. It appears to be floating towards you, with the sap coloured leaves floating as a group some distance behind. What you have created here is colour depth. The bright highlights of the flower excite the eye, and appear closer than the darker tones behind it. The sap green leaves are of a similar brightness to the mid tones of the flower, but since they are of a similar hue to the background they sit with it rather than come forward like the complimentary flower does.

We now need to bring the sap green leaves closer to the flower so that they appear to belong together. We can start by adding some bright highlights. Take note of the veins in the leaves and the way they curve and fold as you do this.

**1. Mix a thin translucent white and apply this on the leaves to paint the reflections on them.**

**2. Mix a thin translucent lemon yellow and apply this where light shines through the leaves.**

The brightness makes the leaves look closer to the flower now, but they appear to float between it and the background. This is because there is little contrast between the background and the leaves.

**3. Mix up a forest green to a medium consistency, and work this between the leaves where the shadows from the leaves and the flower would fall on the other leaves.**

The contrast will help join the leaves to the flower, but more is needed as the leaves still appear to float. Since the background is light we can do this by adding darkness to the leaves.



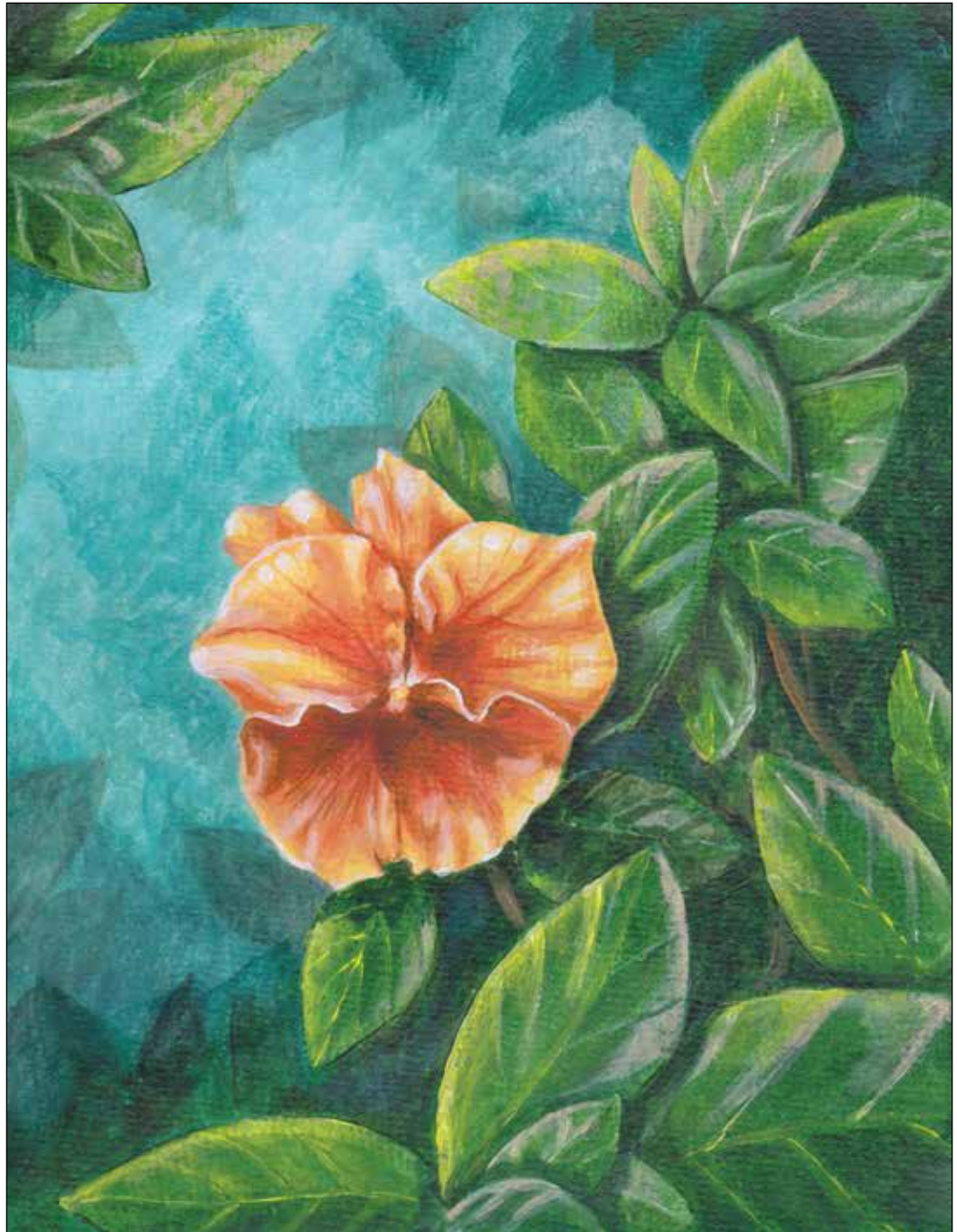
**4. Add a touch of black to the forest green and work in the darker shadows of the background that appears between the leaves in the bottom half of the right side of the picture.**

Leave out areas where stalks would be so that they sit faintly in the shadows. You may want to add a few darker shadows to the leaves at the bottom of the page.

The darker tones in and around the leaves help them to stand out in contrast with the background. The plant seems settled, its parts belong together. Light, dark and colour are in balance.

Yet there is still the appearance of movement. The flower against the blue appears to move towards us, while the sap coloured leaves at the top appear to pull it back to meet with the background. Meanwhile the darkness around the leaves holds the flower together with them. So the plant as a whole appears to move back and forth, while the darkness at the bottom of the page appears to hold the plant steady providing it with a solid base.





Author's acrylic painting based on a Rococo composition

During the time of the French Revolution and Napoleonic wars another art form arose in France which looked back to its more serious past. But Neoclassicism, as this art form was called, did little to further the development of colour. It did however, with its idealogical goals, lead to Romanticism. The artists of this genre utilised prior developments in art studies to romanticize their themes, and then extended the developments further. Romanticism found in colour something akin to its own nature, and compositional use of colour was taken to new heights. New understanding of coloured shadows opened up more pathways for the use of colour, and use of line began to take secondary place to the positioning of hue, tone and saturation.

Nowhere was this more the case, than in England with William Turner. Surrounded by Romantic writers and themes on the idealization of Nature, Turner looked to light itself for his subject matter. He was “directly influenced by Goethe and his Theory of Colour” (James, 2001, p. 22), and dedicated himself to the observation of light in the most varied conditions. He studied the reflection and refraction of light on clouds, water, hard and soft surfaces, and reflective and absorbent materials. And he exposed himself to the most bizarre conditions to do so, sitting out in snow storms, tying himself to the mast of a fishing boat in wild waters, and painting across the water from the burning houses of parliament, to mention just a few (Ackroyd, 2006).

Turner used colour to contrast against itself by use of complementaries and or light and dark. In his later work he took this further by losing the clarity of line formed by the meeting of colours, and instead interplayed reflection and refraction into this meeting with such mastery that his work took on the character of a symphony of coloured light. A prime example of this can be seen in ‘The Fighting Téméraire’, of which Peter Ackroyd says;

“the art of colour itself is taken to the highest possible pitch. It is deployed, like music or the language of poetry, for its own sake without any recourse to some ultimate reality. The light is not of this earth but has the effulgence of a vision.” (Ackroyd, 2006, p. 136)

The eye does not see lines, only fields of coloured light with graduated darkness. And it is this that meets our immediate experience through sight. It is only then that we perceive form, as Van James (2001, p. 20), puts it: “Without our noticing it, the eye traces perceived areas of colour, light, and darkness, making us aware of shape and form -straightness, curvature,



Figure 7.  
*The Fighting “Temeraire” tugged to her last berth to be broken up*  
William Turner c. 1838  
Oil on canvas  
91 x 122 cm  
National Gallery, London

and depth.” Perceiving form requires us to build up this form by using our intellect, yet as James continues;

Experiencing colour that is free of fixed forms is an intermediary step between perceiving physical, material objects and recognizing the creative forces behind them. Thus the biblical declaration: ‘I do set my bow [spectrum of colours] in the cloud, and it shall be for a token of a covenant between me [spirit] and the earth [matter]’ (Gen. 9:13). (James, 2001, p. 21)

Thus Turner’s approach to colour promotes pure perception and stimulates the imagination in such a way that it can give birth to intuition free of material form. In this way his work prepares the way for Impressionism and an array of new approaches to art that arise in the modern era, as artists search to realign the art of painting with its ultimate purpose.



## Science

# Singling Out and Mixing of Colours

One of the great accomplishments of Turner was his ability to capture in paint, the effects of coloured light. This was something quite new, as the mixing of paint pigments produces quite a different effect to that of the mixing of coloured light. Turner needed to understand the science of this as well as making his own observations in order to achieve what he did.

Newton (1669/2010), found that coloured light could be isolated from the spectrum by blocking off the other colours.

### ACTIVITY A

1. Project a narrow beam of light through a prism in a dark room.
2. Project the refracted spectrum onto a white flat area.
3. Take a piece of card with a small hole no larger than 5mm diameter, and hold it up between the prism and the projection so that only one of the spectrum's colours is able to pass through the hole.

The hole acts as a filter, separating one group of coloured rays from the others. A similar thing happens when coloured transparent filters are used whereby a limited range of light rays is allowed to pass through the filter. Both Goethe and Newton found that the singled out colours of the spectrum could be mixed.

### ACTIVITY B

1. Set up red, blue and green lights in a dark room so that they can be shone on a flat white background.

2. Show how red, blue and green coloured light together make white.
3. Show how red and green make a light yellow.
4. Show how red and blue make a light magenta.
5. Show how blue and green make a light cyan.
6. Show how yellow and magenta make a red
7. Show how cyan and yellow make a green
8. Show how cyan and magenta make a blue

However the results of mixing coloured light is different from that of mixing coloured pigment.

### ACTIVITY C

1. Set up medium density watercolours and some painting paper.
2. Apply some blue paint, cover this with red and then paint over it again with green. The result will be black in contrast to using coloured light that created white.
3. Paint red then green. The result is a dark brown, whereas with light it produced a light yellow.
4. Paint blue then red. The result will be a dark purple, whereas with light it produced a light magenta.
5. Paint blue then green. This will produce a dark turquoise, whereas with light it produced light cyan.
6. Paint magenta then yellow and this makes an intense red
7. Paint cyan and then yellow and this makes an intense green
8. Paint cyan and then magenta and this makes an intense blue

When mixing coloured light red, blue and green are considered the primary colours for mixing all hues. They produce lighter colours when mixed together, and the right proportions of the three will produce white. These are called additive colours. Additive colours are used to mix colours on a computer screen.

Cyan, magenta and yellow are referred to as subtractive colours. They are created out of the primary colours in light, but as pigments they are the primary colours used to mix all other colours. When mixed together in the right proportions, these three colours create black. Subtractive colours are what are used to mix colours in printing or to mix paint.

## Art

### The Fighting “Temeraire”

Watercolour on stretched watercolour paper

1. Stretch watercolour paper onto a board, and leave to dry.

Then study Turner's picture, thinking about the underlying colours sitting behind the whole scene. As you do this you can mark out the main shapes of the boats and horizon line.

2. Use a light golden watercolour pencil to lightly and loosely sketch out the main shapes.

Do not use an eraser as this will damage the texture of the paper.

## Spiritual Literature

Hail holy light, offspring of Heav'n  
first born,  
Or of th' Eternal Co-eternal beam  
May I express thee unblam'd? Since  
God is light,  
And never but in unapproached light  
Dwelt from Eternite, dwelt then in  
thee,  
Bright effluence of bright essence  
increase.

*Paradise Lost*  
John Milton 1667  
(Milton, 1667, p. 67)



3. Mix up a light watery golden yellow and a light watery ultramarine blue. Apply these colours with a large flat brush.

Be careful not to mix them unintentionally as they will produce green. We don't want green in the

sky area, but we do want the colours to touch. Where brown or black is in the finished picture, green can sit beneath it so here the two colours can overlap.

4. Add a touch more colour to the blue and yellow and paint in another layer to intensify the colours where they need to get stronger.

Use a wide flat brush and make strokes which are wet, but not so wet that water can collect on the page and create coloured edges. Overlap stroke over stroke as the painting dries, building up the tones and creating the effect of fluctuating light. In the clouds the strokes should be broad, rounded and soft. On the water the strokes should be elongated, horizontal and hold their shape.



Be careful around the edges of the ship when working with the blue. Adapt the brush size to suit the area you are working in always using a flat brush and just enough paint so as to push it around and cover the area you are working on, but not so much that it creates a water puddle. If this does happen quickly mop up the extra with a clean dry brush so that it doesn't drip.

5. Mix a watery warm red and begin applying this to the sky and sea, using the same kind of strokes previously used.

The resulting colour over the yellow will be orange, and this will change from pale yellow-orange through to a rich warm red as you build up the layers of strokes. Observe how this feels.

## Spiritual Literature

When his [God] celestial rays begin to shine within us, then we see in the true light; then there is no truth to which we do not instantaneously assent, as we admit, without any process of reasoning, the splendor of the sun, the moment we behold his rising beams.

*Spiritual Progress*  
Francois Fenelon, 1695-1715  
(Fenelon, n.d., chap. IV II)

# Coloured shadows

If we look at our shadow in direct sunlight, or any other source of direct light, we find that our shadow is gray. The gray lightens if there is cloud, or some other surface for the light to reflect off as they send light rays into the shadow area.

However Goethe (1810/1970), noticed that under certain circumstances shadows can be coloured. This can be demonstrated in the following activity.

### ACTIVITY A

1. Shine a blue diffused light over a white flat surface. Make sure the light is from enough distance away so that the light floods the area with a slight tint.
2. From another angle shine an orange light over the same area, but have this light closer so it is brighter than the blue.
3. Stand an object in front of the orange light so that it casts a shadow.

Now you can observe that the shadow produced is blue. It appears a much more prominent blue than the blue seen if the orange light is turned off. Goethe believed that this was because the orange light excites the eye to produce its complimentary, therefore the faint blue seems to become much more prominent. We can see examples of this in a moonlit night if there is orange tinged street lighting present.

### ACTIVITY B

1. Shine a diffused white light over a white flat surface from far enough away so that the light floods the area with a slight tint.
2. From another angle shine an orange light over the same area so that it is closer and more powerful than the white.

3. Stand an object in front of the orange light so that it casts a shadow.

Observe now that the shadow still appears blue, but the blue is less intense than when blue light is used to flood the area. In both cases the shadow is the opposite colour to the light casting the shadow.

However if three lights are used the effect is more complex.

### ACTIVITY C

1. Shine a white light over a white flat surface.
2. From another angle shine a red light over the same area.
3. From another angle shine a yellow light over the same area.
4. Stand an object in front of the lights so that it casts three shadows.

Observe now that there are three different coloured shadows that are black where they cross. Where the red and white lights flood the area, and the yellow light casts a shadow, the shadow appears purple, the complementary colour to the light surrounding it. Where the yellow and white lights flood an area, a shadow is cast by a red light, and the shadow appears green, the opposite colour to the red surrounding it. But where the red and yellow light flood an area, and a white light casts a shadow, the shadow is not black, white light's opposite, but is a tone of red, and results from the mixing of yellow and red light.

Therefore shadows are not only the complementary colour of the light that creates them,



but where white light is used, the shadows of the white light take the colour of the mix of light flooding the background.

#### ACTIVITY D

1. Shine an orange light over a white flat surface.
2. From another angle shine a blue light over the same area.
3. Stand an object in front of the lights so that it casts two shadows.
4. From another angle shine a magenta light so that it shines over where the two shadows fall.

Observe how you can get a blue, orange and green shadow. But note also that the magenta light, shining over the black of the overlapping blue and orange shadows, is now purple. Thus even the dark part of shadows can be coloured, and that these can be a different colour to the rest of the shadow.

## Spiritual Literature

All come forth to the cheerful light  
How lively, see! the multitude sallies,  
Scattering through gardens and  
fields remote,  
While over the river, that broadly dallies,  
Dances so many a festive boat;  
And overladen, nigh to sinking,  
The last full wherry takes the stream.  
Yonder afar, from the hill-paths  
blinking  
Their clothes are colours that softly  
gleam.

*Faust: from Faust to Wagner*  
Johann Goethe, 1832  
(Goethe, 1832, part. 2)



## Art

### The Fighting “Temeraire”

Watercolour on stretched watercolour paper

1. Work back and forth between the red, yellow and blue, building up the light reflections in the fluctuating clouds and water. Where all three colours overlap you get the brown tones on the boats and in the sea.
2. Now you can take stronger mixtures of paint. Some reproductions show the red more prominently than in others, so choose how you want to paint this. You can strengthen the red by bringing in some crimson in the sky.
3. Work on the ships with golden yellow and orange-brown.
4. Bring in touches of orange around the gold to give the ships a glow.
5. Then bring in the black, in the details on the ships and in the sea to the right of the picture.

Have a final look at the painting and work with the crimson, golden-yellow, orange-brown, and black to bring intensity to areas that still need building up. Make sure that light areas are not overworked. And be strategic in where you add darkness.

Keep standing back and looking at the painting from a few metres back. Adjust to suit colour balance and balance of dark and light. Check that light reflections line up with their light source, and that mirrored images line up with what they are mirroring. Note that there is a light to the left side of where Turner would have been working, and this light casts a white reflection in the water on the left. It is this light, bouncing off the water and the clouds above, coupled with the sun's light reflecting off the clouds directly above, that allow the darker side of the “Temeraire” to still reflect and glow.





Author's watercolour painting of Turner's  
*The Fighting "Temeraire" tugged to her last berth to be broken up*



## Lifetimes of Authors, Artists and Scientists Used in this Book

Name	Lifespan
Diego Velázquez	1559 – 1660
Michelangelo Merisi da Caravaggio	1571 – 1610
Nicolas Poussin	1594 – 1665
Rembrandt	1606 – 1669
John Milton	1608 – 1674
Jan Vermeer	1632 – 1675
Isaac Newton	1642 – 1726/7
François Fénelon	1651 – 1715
Jean-Honore Fragonard	1732 – 1806
Johann Wolfgang von Goethe	1749 – 1832
Friedrich Schiller	1759 – 1805
Friedrich Schleiermacher	1768 – 1834
William Turner	1789 – 1862
Charles Hodge	1797 – 1878
Friedrich Nietzsche	1844 – 1900

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